Discussion Document

Proposed
Site Selection Criteria
for The Development of a
Hazardous Waste Management
System

Manitoba
Hazardous Waste
Management Corporation

-020587

Environmental Policy Statement

The Manitoba Hazardous Waste Management Corporation is committed to the preservation and enhancement of environmental quality through the development of a hazardous waste management system for the Province. This undertaking is a fundamental element needed to achieve the broader objectives of universal environmental stewardship and sustainable economic development within Manitoba.

To reach these goals, the Corporation uses the following policy objectives as the basis for the performance of its work.

- Minimize waste generation and maximize resource conservation through the promotion and facilitation of waste reduction, recycling, re-use and recovery at source.
- Ensure that all activities involved with the handling, storage, treatment and disposal of waste and residue products are consistent with the protection of public health and environmental quality.
- Earn public approval of the system and its components through open and responsive communication and through public participation in all aspects of their development and operation.
- Encourage economic development through the provision of a cost-effective waste management system and the enhancement of environmentally based enterprises.
- Foster and promote contemporary environmental values and policies through public education and research, as well as by example.
- Assume, in perpetuity, the environmental stewardship of wastes and residues placed in the Corporation's custody.

Corporate Profile

The Manitoba Hazardous Waste Management Corporation is a commercial Crown corporation established to develop and operate a hazardous waste management system for Manitoba. Its mandate is to provide for the handling of regulated hazardous wastes from their source through to their treatment and disposal, consistent with high standards of public health, safety and environmental quality.

Manitoba Hazardous Waste Management Corporation

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DISCUSSION DOCUMENT

PROPOSED SITE SELECTION CRITERIA FOR THE DEVELOPMENT OF A HAZARDOUS WASTE MANAGEMENT SYSTEM

by:

The Manitoba Hazardous Waste Management Corporation

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October 1988

PREFACE

The Facility

The Manitoba Hazardous Waste Management Corporation is a commercial Crown corporation with the mandate to develop a hazardous waste management system in the province. One of the first steps in achieving this goal is the selection of a central site for the establishment of a treatment and disposal facility.

The proposed facility is a relatively small industrial plant designed to treat hazardous materials. There will be no on-site disposal of untreated hazardous waste. Provision will be made for the permanent storage of treated residues at the site using either an engineered landfill or above ground containment facility. The central facility will be developed in increments to meet provincial hazardous waste management requirements giving consideration to waste types, quantities and best available technology.

The Site

Where is the best site? This is a question to which there is no simple or right answer. The Corporation is of the opinion that there is no single "best" site because this judgement will vary from individual to individual. Through the development of siting criteria we have defined a set of characteristics that will be considered in selecting an acceptable site. There are potentially numerous acceptable sites, all of which can meet the technical, environmental, land use, social and economic requirements of this project. Ultimately, the site must be acceptable to both the community and local residents.

Public Involvement

The Corporation recognizes the value of public support and the need to incorporate public concerns into the site selection process. Our site selection process is voluntary and provides considerable opportunity for public input in the selection and evaluation of potential sites. We will undertake detailed site selection only within those communities that invite us to do so and demonstrate ongoing public support for facility development.

In Perspective

This report is intended to stimulate public discussion on issues related to siting a hazardous waste management system in Manitoba. It provides a set of proposed site selection criteria which define the characteristics of an acceptable site. It also includes the results of a provincial screening exercise which identify those areas of the province with the best potential to find acceptable sites. This information will provide direction to communities considering participation in the site selection process.

We cannot permanently solve provincial hazardous waste management problems without a site for facility development. This project will benefit all Manitobans and will provide direct employment and economic benefits to the host community. We welcome the opportunity to discuss this project in detail with interested communities and work together towards the development of a provincial waste management system.

SUMMARY

Introduction

This report was prepared as a discussion document on the siting of hazardous waste storage, transfer, treatment and disposal facilities in Manitoba. It identifies proposed technical, environmental and land use criteria, and provides justification for each. It is intended to stimulate public discussion on issues related to facility siting thereby allowing public input prior to the finalization and application of these criteria. The report is prepared as part of the first phase of the overall site selection process which was described in detail in a previous publication (Latonas, 1988). The criteria presented are generally consistent with those applied in other jurisdictions, a summary of which has been included in the Corporation's previous publication and in the appendices to this document.

Three sets of criteria are proposed as outlined below:

- Provincial Screening Criteria include natural hazard, environmental, technical and land use criteria which, when applied on a province-wide basis, eliminate large areas where the probability of finding suitable facility sites is low.

- Regional Site Selection Criteria represent detailed technical, environmental and land use criteria for the identification and evaluation of potential sites for a fully integrated hazardous waste management facility. These criteria will be applied in "acceptable regions" as identified through the provincial screening process.

- Transfer Station Site Selection Criteria address those siting issues pertinent to the location of regional transfer stations.

The following sections provide a summary of the main report. It is emphasized that this is a public discussion document outlining the Corporation's viewpoint. Readers are encouraged to critically review the document and relay comments to the Corporation directly or discuss them with Corporation staff at the regional open houses.

System Description

The proposed Manitoba hazardous waste management system will consist of a central facility supported by a series of regional transfer stations. The central facility will ultimately meet the storage, treatment and disposal requirements for provincially regulated hazardous waste. However, it will be developed on an incremental basis as the need for specific capability and/or technology is justified. Criteria developed for facility siting assume that a fully integrated facility will ultimately include the following components:

- analytical facility;
- centralized storage, materials handling and volume reduction facilities;
- physical/chemical treatment facility;
- organic waste treatment facility;
- treatment residue stabilization facility;
- treatment residue repository; and
- supporting infrastructure for the above.

Specific treatment and disposal technologies will be chosen for the facility based on the types and quantities of waste generated in Manitoba and the best available technology giving consideration to capability, technical, environmental and economic performance.

Transfer stations will be added to the system as the need is justified. They will be relatively small, consisting primarily of a warehouse/office building and associated materials handling facilities. Transfer stations will function as the "door to the system" and will be developed to meet regional hazardous waste management requirements.

All facilities will be designed, constructed and operated in compliance with provincial acts and regulations.

Provincial Screening

The provincial screening process was developed to provide an efficient means of identifying potentially acceptable regions of the province for siting an integrated hazardous waste management facility. It is the first step in the site selection process and is, in essence, the qualification of regions where the probability of finding sites which will meet the more detailed regional site selection criteria is maximized.

This is achieved by applying provincial "exclusion" criteria to eliminate areas which exhibit significant constraints to facility siting. Provincial screening criteria were developed to identify:

- areas where natural hazards pose an unacceptable risk to facility integrity;
- areas which do not provide for the natural protection of the environment; and
- areas where facility development is not technically feasible.

Criteria were developed in four general categories as shown in Table 1:

TABLE 1
PROVINCIAL SCREENING CRITERIA

CATEGORY	EXCLUSION CRITERIA
Natural Hazard	100-year flood plains Seismic risk areas Karst terrain
Environmental Protection	Groundwater pollution hazard areas Provincial parks Wetlands Class 1 agricultural lands Ecological reserves and wildlife lands
Technical	Bedrock outcrop areas Permafrost areas
Land Use	Federal lands

These provincial exclusion criteria were mapped from existing published information using a computerized geographical information system (Appendix C). The results are presented in Figure 1. Those areas not excluded through the application of these criteria are considered to be relatively free of siting constraints at this level. Application of the more detailed regional site selection criteria is considered appropriate in these areas

Figure 1 presents a general indication of those areas where significant constraints exist. It does not absolutely exclude these regions from consideration. More detailed analysis within these regions could potentially identify constraint free areas not found at the provincial level. Figure 1 does, however, focus attention on those areas where the probability of finding acceptable sites is greatest.

Site Selection Criteria: Central Facility

This section of the report presents detailed criteria to assist in the identification and evaluation of potentially acceptable sites. It is stressed that these are proposed criteria only. The Corporation recognizes the need to incorporate public concerns and opinions in

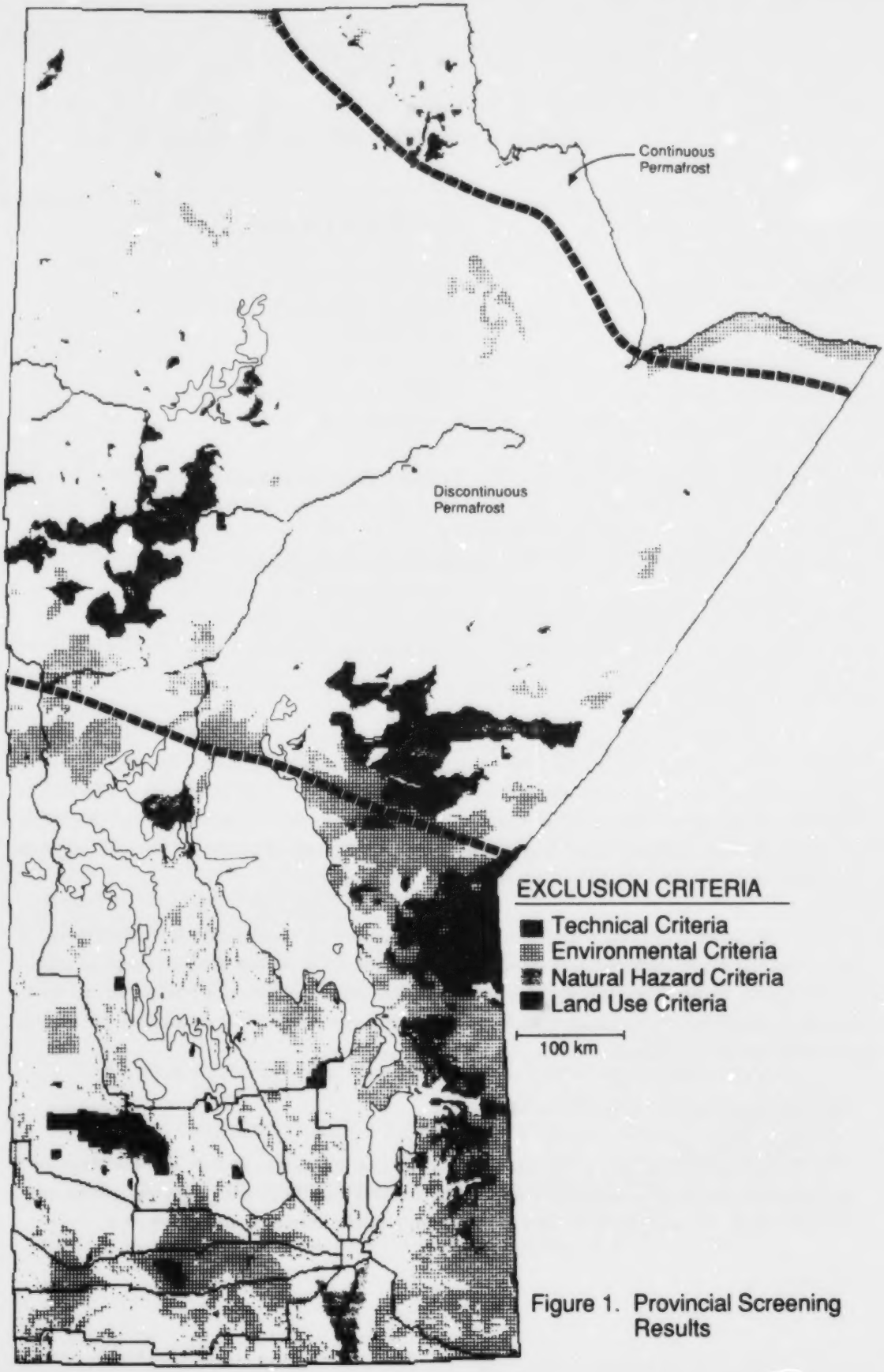

Figure 1. Provincial Screening Results

the site selection process. Therefore, these criteria are open to review and comment throughout the process and will only be finalized and applied with the support of community-selected Advisory Committees in areas where the Corporation has been invited to pursue the detailed search for potential sites.

These criteria were developed on the premise that engineering design and controls would not be solely relied upon to minimize the probability and/or consequence of an uncontrolled contaminant release at the site, however unlikely that may be. Therefore, a main focus of the criteria is to provide natural barriers to the transport of contaminants via environmental pathways. In addition, it is recognized that certain land uses are not compatible with this type of industrial development. Therefore, criteria dealing with land use issues are also proposed.

The criteria differ in their overall importance to facility siting. The following four categories of criteria are proposed:

- o Essential criteria define required site characteristics; areas which do not meet the essential criteria will be eliminated from further consideration.

- o Unacceptable criteria identify site characteristics which are considered incompatible with facility development; areas with unacceptable characteristics will be excluded from consideration in the site selection process.

- o Desirable criteria define site characteristics which are preferred, but not essential; areas exhibiting desirable characteristics will be given preference over those which do not.

- o Undesirable criteria define site characteristics which are undesirable but not unacceptable; areas with these characteristics will be given a lower priority in the site selection process.

Tables 2, 3 and 4 summarize the proposed technical, environmental and land use criteria, respectively. Criteria classified as either "essential" or "unacceptable" are exclusionary. Areas which do not meet an essential criterion, or which exhibit an unacceptable characteristic will be excluded from consideration. Absence or presence of "desirable" and "undesirable" criteria will not rule out any areas. However, those criteria can help to evaluate the relative suitability of alternate sites. They may also dictate incremental mitigative and design measures, thereby influencing economic considerations in any final evaluations.

TABLE 2

PROPOSED REGIONAL SITE SELECTION CRITERIA

Technical Criteria

Component	Criteria	Classification	Justification
Access	Accessible by highway	Essential	Necessary for facility operation
	Accessible by rail	Desirable	Increases flexibility of operation
Services	Regional availability of electric power natural gas, and water	Essential	Required for facility operation
Land Requirement	65 hectares (160 acres)	Essential	Required for facility operation
	Crown land	Desirable	Land use control

TABLE 3

PROPOSED REGIONAL SITE SELECTION CRITERIA

Physical and Environmental Criteria

Component	Criteria	Classification	Justification
Geology	Karst terrain	Unacceptable	Facility integrity
	Seismic prone areas	Unacceptable	Facility integrity
Surficial Geology and Topography	Clay or till of sufficient thickness and low permeability to meet groundwater protection criteria	Essential	Protection of groundwater quality
	Unstable terrain	Unacceptable	Facility integrity
	Steeply rolling terrain	Undesirable	Minimize surface water runoff

Table 3 (continued)

Component	Criteria	Classification	Justification
Surface Water	100-year flood plains	Unacceptable	Protection of facility integrity/ surface water quality
	Within 500 metres of lakes and continuously flowing streams or rivers	Undesirable	Protection of surface water quality
	Provincially designated high quality watersheds	Undesirable	Protection of surface water quality
	Defined watersheds directly feeding reservoirs used for public water supplies	Unacceptable	Protection of surface water quality
Ground Water	Unconfined aquifers (ground water pollution hazard areas)	Unacceptable	High pollution hazard
	5 m of clay/till base with a bulk hydraulic conductivity of 10^{-7} cm/sec or less	Essential	Protection of groundwater quality
	10 m of clay/till base with a bulk hydraulic conductivity of 10^{-7} cm/sec or less	Desirable	Protection of groundwater quality
	TOT_{100} greater than 100 years	Desirable	Protection of groundwater quality
Wetlands	Wetland areas	Unacceptable	Protection of wetland habitat
Climate and Air Quality	Within 1 kilometre of residential zoned land in cities, towns and villages	Unacceptable	Minimization of risk
	Minimum population density in predominant downwind directions	Desirable	Minimization of risk

TABLE 4

PROPOSED REGIONAL SITE SELECTION CRITERIA

Land Use Criteria

Component	Criteria	Classification	Justification
Urban Centres	Within 50 kilometres of a town	Desirable	Facility access and servicing
	Within 100 kilometres of a city	Desirable	Facility access and servicing
Public and Private Facilities	Within 200 metres of a private residence	Unacceptable	Minimization of risk
	Within 1000 metres of public facilities	Unacceptable	Minimization of risk
	Minimum population density in vicinity	Desirable	Minimization of risk and future land use control
Parks	Existing or proposed federal, provincial or municipal parks	Unacceptable	Protection and preservation of parkland
Heritage Resources	Designated or proposed heritage resources	Unacceptable	Protection of heritage resources
Land Claims	Registered native land claims	Undesirable	Land use conflict
Agriculture	Class 1 agricultural lands	Unacceptable	Protection of inherent agricultural capability
	Class 2 and 3 agricultural lands	Undesirable	Minimize conflict with agricultural production
	Intensive agricultural land uses	Undesirable	Minimization of risk and land use conflict
Forestry	Within a designated seed orchard	Unacceptable	Protection of key forest production lands
	Class 2 and 3 forestry lands	Undesirable	Protection of high productivity forestry lands

Table 4 (continued)

Component	Criteria	Classification	Justification
Fisheries	Provincially designated high quality watersheds	Undesirable	Protection of surface water quality
Wildlife	Designated wildlife management areas or wildlife refuges	Unacceptable	Protection of key wildlife habitat
	Class 1 wildlife lands	Undesirable	Protection of key wildlife habitat
Ecological Reserves	Within an existing or proposed Ecological Reserve	Unacceptable	Protection of ecologically significant areas of the province
Mining	Active and inactive mining areas	Unacceptable	Land use conflict and facility integrity
Proposed Development Areas	Designated Reservoir Areas and Power Reserves	Unacceptable	Minimize future land use conflict
	Designated development reserves and active proposal areas	Undesirable	Minimize land use conflict

The proposed regional site selection criteria were prepared following review of siting requirements in other jurisdictions. In addition, they incorporate the response to the Clean Environment Commission (1987) hearings on hazardous waste management issues in Manitoba, particularly public comments concerning on the siting issue. A review of this information is provided in the Corporation's siting process discussion document (Latonas, 1988) and is summarized in the Appendices.

Site Selection Criteria: Transfer Stations

Transfer stations will be required to provide an equitable and cost effective service to all provincial generators. Therefore, they must be strategically located giving consideration to the provincial distribution of waste generation.

Transfer stations will function to receive, package, store and convey hazardous wastes to the Corporation's central facility. They will be licensed as Regional Collection Facilities under the Dangerous Goods Handling and Transportation Act. As such, they will not normally accumulate large quantities of wastes or store wastes for periods greater than 90 days. The facilities will be relatively compact and resemble, in general appearance, a traditional warehouse operation.

Transfer stations will be sited with utility in mind, ideally within or adjacent to existing urban centres to ensure accessibility and proximity to potential markets. Similarly it is not necessary to achieve the same level of secondary environmental containment as is considered appropriate for the central facility site, since their operation will not involve treatment or residue disposal. Therefore, the proposed criteria allow greater flexibility for the application of engineering solutions in lieu of natural barriers to contaminant transport.

Tables 5, 6 and 7 present the proposed technical, environmental and land use criteria considered appropriate for siting transfer stations. Criteria are classified as "essential", "desirable", "unacceptable" or "undesirable" consistent with the proposed regional site selection criteria. Justification is also provided for the inclusion of each criterion.

Regions of Greatest Interest

It is obvious that not all "constraint free" areas identified through the provincial screening process (Figure 1) will meet the detailed requirements of an acceptable site as proposed in the site selection criteria. Therefore, evaluation of these criteria on a provincial basis is warranted to provide more direction to the next phase of site selection.

TABLE 5

PROPOSED TRANSFER STATION SITING CRITERIA
Technical Considerations

Component	Criteria	Classification	Justification
Access	Accessible by Highway	Essential	Necessary for facility operation
	Accessible by rail	Desirable	Increases flexibility of operation
Services	Local availability of essential services	Essential	Necessary for facility operation
Land Requirement	1.6 ha minimum	Essential	Minimum lot size to accommodate stand-alone facility

TABLE 6

PROPOSED TRANSFER STATION SITING CRITERIA
Physical and Environmental Criteria

Component	Criteria	Classification	Justification
Geology/ Surficial Geology	Unstable terrain	Unacceptable	Facility integrity
Ground Water	Unconfined aquifers	Undesirable	High pollution hazard
	Clay/till base with a bulk hydraulic conductivity of 10^{-7} cm/sec or less	Desirable	Protection of groundwater quality
Surface Water	100-year flood plain	Unacceptable	Protection of facility integrity/ surface water quality
	Within 200 m of lakes and continuously flowing streams and rivers	Unacceptable	Protection of surface water quality
Climate and Air Quality	Minimum population density in predominant downwind direction	Desirable	Minimization of risk

TABLE 7

PROPOSED TRANSFER STATION SITING CRITERIA
Land Use Criteria

Component	Criteria	Classification	Justification
Zoning	Industrial zoned land	Essential	Compatibility with existing land use
	Designated or discretionary use under existing land use By-law	Essential	Compatibility with existing land use
Private and Public Facilities	200m from residential zoned land and 500m from public facilities	Essential	Minimize land use conflicts and public perception of impact

Of the "essential" criteria proposed for the central facility site, only those related to surficial geology are suitable for site screening on a provincial basis. The most important criteria in defining suitable areas are those related to the thickness and type of surficial materials. In order to identify those non-excluded regions having the best surficial geology, the following "inclusion criteria" have been mapped:

- the region must be underlain by clay, glacial till or a combination of the two; and
- clay and till deposits should be 10 metres or greater in thickness.

When applied in combination with the provincial screening results, these criteria identify regions with significant potential to meet all siting requirements.

Figure 2 shows only those areas which are free of provincial constraints and have the desired surficial deposits. Based on the results of this work, the greatest potential to meet the technical and environmental site requirements are in those areas identified in Figure 2. Detailed information was not available for northern Manitoba and therefore, consistent results for the entire province cannot be presented. The level of detail required for the next stages of site selection will represent a significant constraint to siting in the north because of this lack of information.

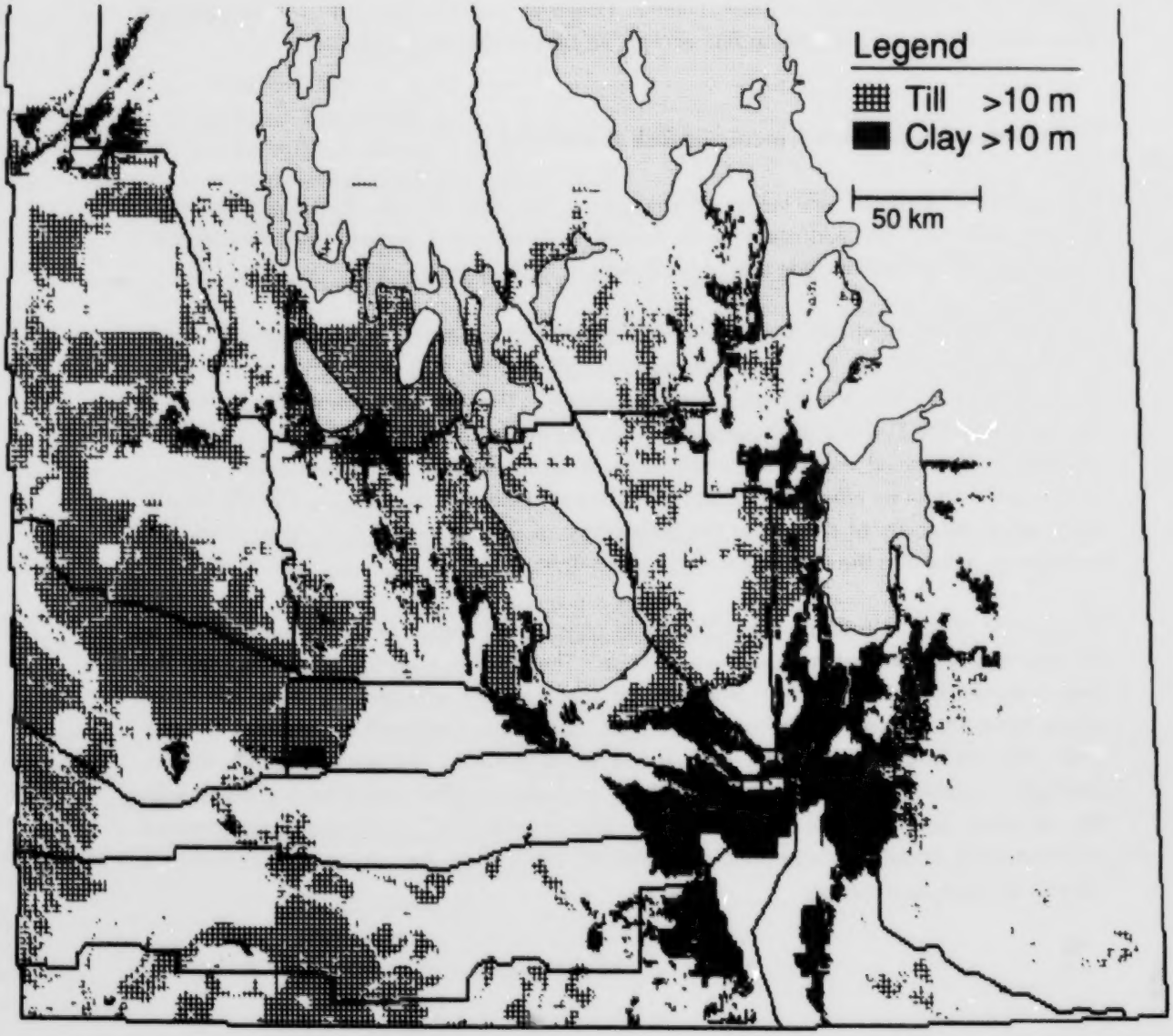

Figure 2. Regions of Greatest Interest

The province has been painted with a "broad brush" in this process and the results should be interpreted with some caution. Potentially acceptable areas may have been inadvertently eliminated either through the provincial screening process or because of limitations regarding detailed information for the inclusion criteria. However, these results focus our attention on those areas where the potential to find acceptable sites is considered greatest.

Environmental Impact Assessment and Risk Assessment

The potential impacts of facility development on the natural and socio-economic environments will be addressed in a formal environmental impact assessment (EIA) document. The EIA will include a risk assessment as a major component.

No facility development can be accomplished totally without environmental impacts or risk. It is the function of the EIA to identify impacts, place them into perspective and propose measures to minimize and mitigate potential effects. The risk assessment, as an integral component of the EIA, will deal specifically with the issues of transportation risk and public exposure to increased risk as a consequence of facility operation. These items are site specific and cannot be effectively incorporated into site selection criteria. The EIA will identify the relative suitability of sites from the perspective of environmental impacts and risk and incorporate these into the evaluation of site alternatives.

The process of site selection must ultimately involve a combination of the criteria outlined in this report and an impact management process. The latter is a joint process involving the local community, with particular emphasis on those directly affected. If there are cases where trade-offs among the various criteria are necessary, these will be resolved through open discussion and negotiation with the affected parties. Mitigation, compensation, contingency planning and joint problem solving are measures that would be negotiated with the affected people and organizations. This negotiation, combined with detailed environmental, social and economic assessments, will ensure the criteria are applied in a rational and sensitive manner.

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1.0 INTRODUCTION

The Province of Manitoba initiated development of a Hazardous and Special Waste Management Program in 1982 in response to increasing environmental awareness and concern regarding the appropriate collection, treatment and disposal of hazardous wastes in the province. The program was developed by the Hazardous Waste Management Section of Manitoba Environment and Workplace Safety and Health. A series of public and technical meetings and hearings were held by the Department and the Clean Environment Commission to solicit the input of the public and other interested stakeholders. These meetings and hearings established a public forum for the consideration of stakeholder input and concerns regarding the establishment of the provincial hazardous waste management system (Kennedy, 1982, ME&WSH, 1983, Yee et al. 1985, and CEC, 1987).

In November 1986, a commercial Crown corporation was established to act as the proponent of a Hazardous Waste Management System (The Manitoba Hazardous Waste Management Corporation Act, 1986). The Manitoba Hazardous Waste Management Corporation (Corporation) started operation in August 1987 and is currently proceeding with establishing the system's scope and testing its feasibility. A major activity in this work is that associated with facility siting.

A previous "Discussion Document" (Latonas, 1988) presented the proposed site selection process and its stages as outlined below:

- Phase 1: Development of the process and criteria for the siting of a hazardous waste management system. Phase 1 includes significant opportunity for public review and comment on the Corporation's proposed activities and presents the results of provincial screening to identify suitable regions for consideration in the siting process.

- Phase 2: Identification of potential host communities. Phase 2 will concentrate on identifying areas of the province which exhibit acceptable technical, environmental and land use characteristics and which express local public support or interest in potentially hosting facility development.

- Phase 3: Detailed site selection and evaluation. The Corporation will proceed, with input from local Advisory Committees, to identify and evaluate potential facility sites in each host community. These will be evaluated through the environmental assessment process and a development proposal will be prepared for the preferred alternative(s).

The purpose of this report is to present, for public review and comment, a detailed set of criteria for use in selecting (1) a suitable site for a central integrated waste management facility in Manitoba, and (2) a number of sites for waste collection and transfer stations that will serve all regions of the province.

This "Discussion Document" on site selection criteria is a key output of the Phase 1 process outlined above. Individual chapters in this report summarize the site selection process, provide a preliminary project description, present results of the provincial screening process, and present in detail the proposed site selection criteria that will be applied, at the regional level. Siting requirements for collection and transfer facilities are also addressed.

Preliminary results of the provincial screening process are presented in Chapter 4. Using a computer based geographical information system, several maps are presented to identify areas considered unsuitable for facility development based on technical, environmental and land use constraints. The final chapter identifies potential regions of greatest interest based on the results of the provincial screening exercise and inclusion of specific site requirements. Results are presented as a provincial map which depicts those areas where the potential to find sites which will meet the proposed detailed criteria is the greatest.

This map will be of interest to those communities potentially interested in participating in the site selection process. Communities located in these identified areas have an excellent potential to participate in Phase 2 of the site selection process and are encouraged to contact the Corporation.

This report is a discussion document and as such proposes criteria for consideration in the selection of potential sites to be incorporated into the provincial hazardous waste management system. Public review and comment on these criteria are encouraged. A series of regional open houses will be sponsored by the Corporation to publicly discuss the proposed site selection process and criteria. Public response and comments received through this process will be used to modify both the process and the siting criteria to more closely reflect public interest and concern in this regard.

2.0 PROJECT DESCRIPTION

2.1 Introduction

The following sections address the basic requirements of the Manitoba hazardous waste management system. Although individual technologies have not yet been selected to treat specific waste streams, this section identifies the "generic" system components and technologies likely to be required and outlines the basic principles to be followed in the selection of those technologies.

In order for a hazardous waste management system to be universal and to provide equitable service and non-selective access to all Manitoba hazardous waste generators, the following principles are being applied to the system's development:

- exploitation of the potential for source-based waste management;
- inclusion of public input in the development process;
- recognition that public acceptance is a fundamental component of facilities development;
- selection and sizing of system facilities to meet projected needs; and
- optimization of system economics and capital commitment requirements.

2.2 Assumptions Adopted in the Siting Process

The overall approach adopted by the Corporation involves development of the system on an incremental basis as the need for specific components and/or technology is justified. However, for the purpose of selecting a site it is assumed that the system may ultimately involve a central facility capable of providing storage, treatment and disposal for all provincially regulated hazardous waste. It will also be supported by a number of regional transfer stations.

The site selection process incorporates the following assumptions in the development of siting criteria to ensure that overall project requirements are addressed:

- the site selection process addresses overall system requirements, i.e., locations for a central facility as well as regional transfer stations;

- criteria developed for facility siting assume that a fully integrated waste storage, treatment and disposal facility will ultimately include:

    - analytical capability;
    - centralized storage and materials handling facilities;

- waste volume reduction facilities;
- physical/chemical treatment facility;
- organic waste treatment facility (such as an incinerator);
- treatment residue stabilization facility; and
- treatment residue repository.

o currently available estimates of waste types, distribution and quantities (Yee et al., 1985) are assumed initially and will be updated as more current estimates of the waste market become available.

Two studies have recently been commissioned to assist in defining system requirements and scope. These include a technology review of applicable waste treatment processes and a provincial waste market characterization. These studies will help define the quantities and types of wastes available to the system and will identify the technologies best suited to handle anticipated waste streams.

2.3 The Central Facility

2.3.1 Central Facility Description

The site selection process, as proposed, concentrates on the identification and selection of a central facility site. This central facility will be developed on an incremental basis, providing for maximum flexibility in effectively managing the anticipated volumes and variety of waste streams.

The operational portion of such a site, based on similar facilities elsewhere, will require from five to twenty hectares (12 to 50 acres). Additional land will be required for potential facility expansion and dedicated buffer zones. Other fully integrated facilities in Canada have established a total land requirement of approximately 130 hectares (320 acres), and for initial planning purposes a similar requirement is assumed for this facility.

The initial increment to facility development will likely involve:

o administration building;

o waste receiving, materials handling and storage capability;

o laboratory facilities;

o a water treatment plant for process wastes and potentially contaminated stormwater runoff;

- o accommodation of waste reduction and recovery equipment acquired previously in conjunction with generator service activities; and

- o the necessary infrastructure required to support mobile treatment technologies and to service a fully-integrated hazardous waste treatment and disposal facility.

Consistent with this will be the provision of appropriate safety and security features, including environmental monitoring, containment, fire protection and plant security systems.

The waste receiving/storage/materials handling component of the facility will consist of an unloading and transfer area, tankage (providing for separate storage of organic and inorganic wastes), facilities to receive sample and store drums and miscellaneous containers, and container decontamination facilities.

Laboratory facilities are required to verify the composition of incoming wastes. The laboratory will also provide the necessary analytical capability to support treatment operations and environmental monitoring requirements at the site.

As viable opportunities are identified, various modular or skid-mounted physical and chemical treatment units, designed to detoxify, stabilize and remove the contaminants in the wastes, could be employed to treat specific waste streams or groups of waste streams.

Similarly, the infrastructure required to support mobile incineration technology will be provided, including a location pad and natural gas supply.

Once the waste market is more clearly defined, the continuing development of central plant facilities would provide for complete physical/chemical treatment, stabilization capability, and solid residue disposal.

Solid residues from treatment processes will be stabilized and solidified. These residues will then be placed in permanent storage in a secure repository, which will be subject to perpetual monitoring and maintenance. For stabilized solid residuals, the relative merits of the currently widely applied secure engineered landfill technology, and the use of various above ground containment technologies require further evaluation. This will include site specific consideration of geotechnical factors, ease of remediation, residue properties and public preference.

For treated aqueous effluents, the options available for disposal include discharge after treatment to a surface watercourse, evaporation, or deep well injection. The preferred option will be determined on the basis of geographical location, detailed site evaluation and public preference.

The initial stage of development will provide the site infrastructure for future application of a selection of either mobile or permanent treatment facilities. While the site will be selected with consideration of the generic technologies involved (eg. incineration, dewatering, reduction), the decision to proceed with any specific component will require a further detailed assessment of its impact and, ultimately, regulatory and community approval.

In the determination and selection of appropriate technologies to provide the above requirements, the Corporation is presently evaluating not only commercially proven technology, but also those in a developmental stage that have potential to meet applicable technical and environmental criteria at the time when the equipment is required. In this way, the initial qualification of the site can be as comprehensive as possible.

2.3.2 Central Facility Development Proposal

A facility development proposal will be submitted to Manitoba Environment and Workplace Safety and Health as required by existing legislation. The proposal will include engineering detail on all proposed technologies to be included in the Stage 1 development. All future site development, consistent with the phased development approach, will be subject to a new development proposal and review pursuant to existing regulatory requirements. Detailed environmental impact assessment (EIA) will be prepared and submitted with each development proposal. The initial development EIA will address many of the environmental concerns associated with the generic technologies anticipated for inclusion in the fully integrated site. Each component will be subject to a detailed engineering and environmental assessment as it is proposed. Figure 2-1 provides an artist impression of what a fully integrated hazardous waste management facility is likely to look like.

The Stage 1 development proposal is scheduled for submission by the end of 1989. Facility construction is scheduled to commence in early 1990 and initial operation of the basic system will commence in 1991. Additional technologies will be added as required with a fully integrated capability being possible as early as 1993.

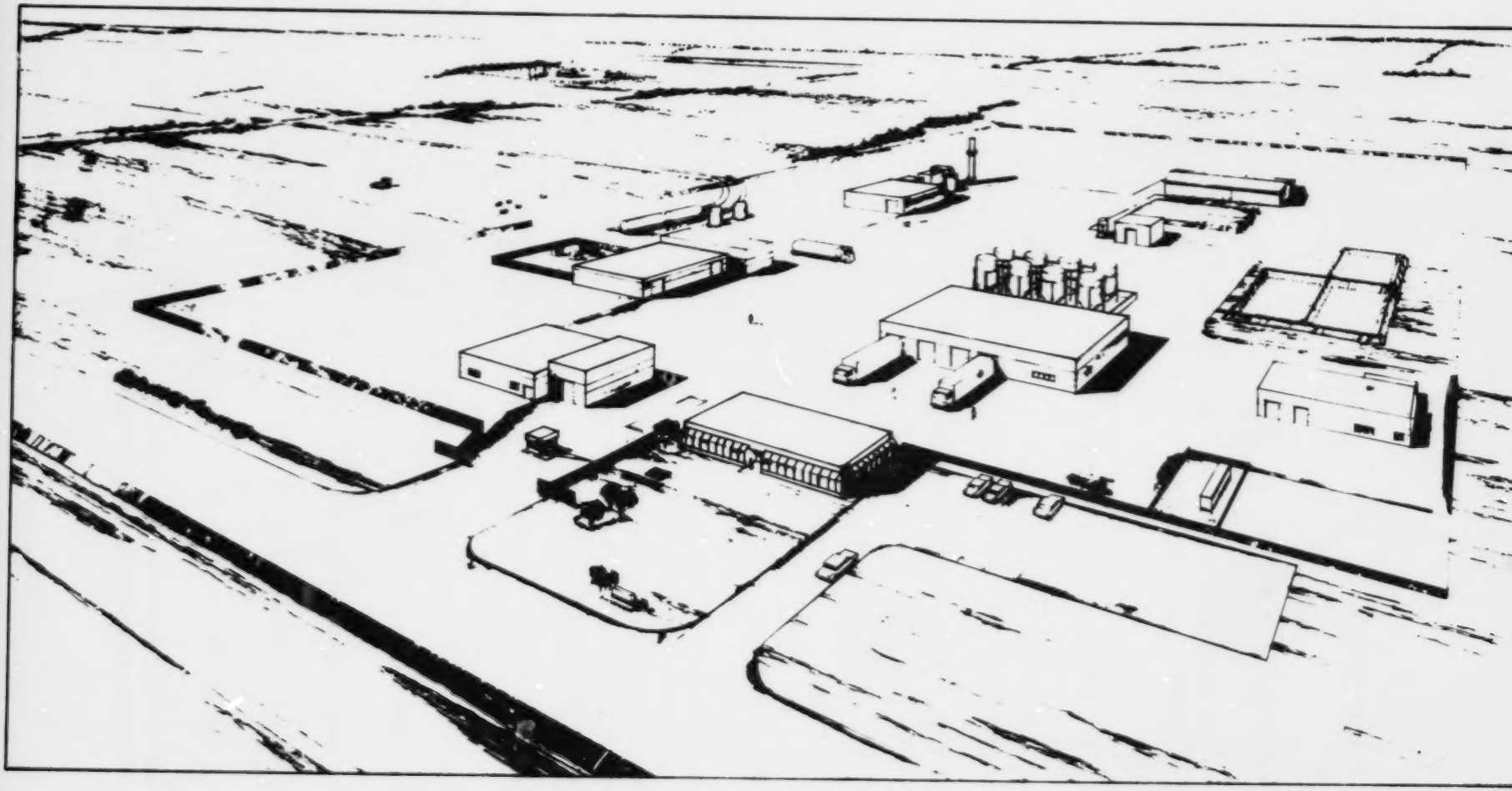

Figure 2-1 **Fully Integrated Hazardous Waste Management Facility**

2.4 Transfer Stations

2.4.1 Transfer Station Description

Transfer stations will be strategically located with respect to the distribution of provincially generated hazardous waste. The primary functions of the transfer stations and associated personnel are to:

- receive regionally generated hazardous waste;
- provide facilities and personnel for the inspection, packaging, storage and volume reduction (if practical) of delivered wastes;
- arrange for the shipment of wastes to a central treatment and disposal facility; and
- provide technical advice to regional generators on matters pertaining to hazardous waste management.

As indicated, transfer stations will function to receive, package, consolidate, store and convey hazardous waste to the Corporation's central facility, or to other facilities, where the waste will be processed. They will be licensed as Regional Collection Facilities under the Dangerous Goods Handling and Transportation Act. As such, the transfer stations will not normally accumulate large volumes of waste or be allowed to store wastes for lengthy periods. Therefore, the facilities will be relatively compact and resemble, in general appearance, a traditional warehouse operation (Figure 2-2).

The following basic facilities will be required at regional transfer stations:

- office building;
- waste receiving/shipping area;
- waste reduction technology (optional);
- waste repackaging area; and
- storage area.

It is anticipated that these components can be contained within a single building and/or yard which is fenced and equipped with a security system.

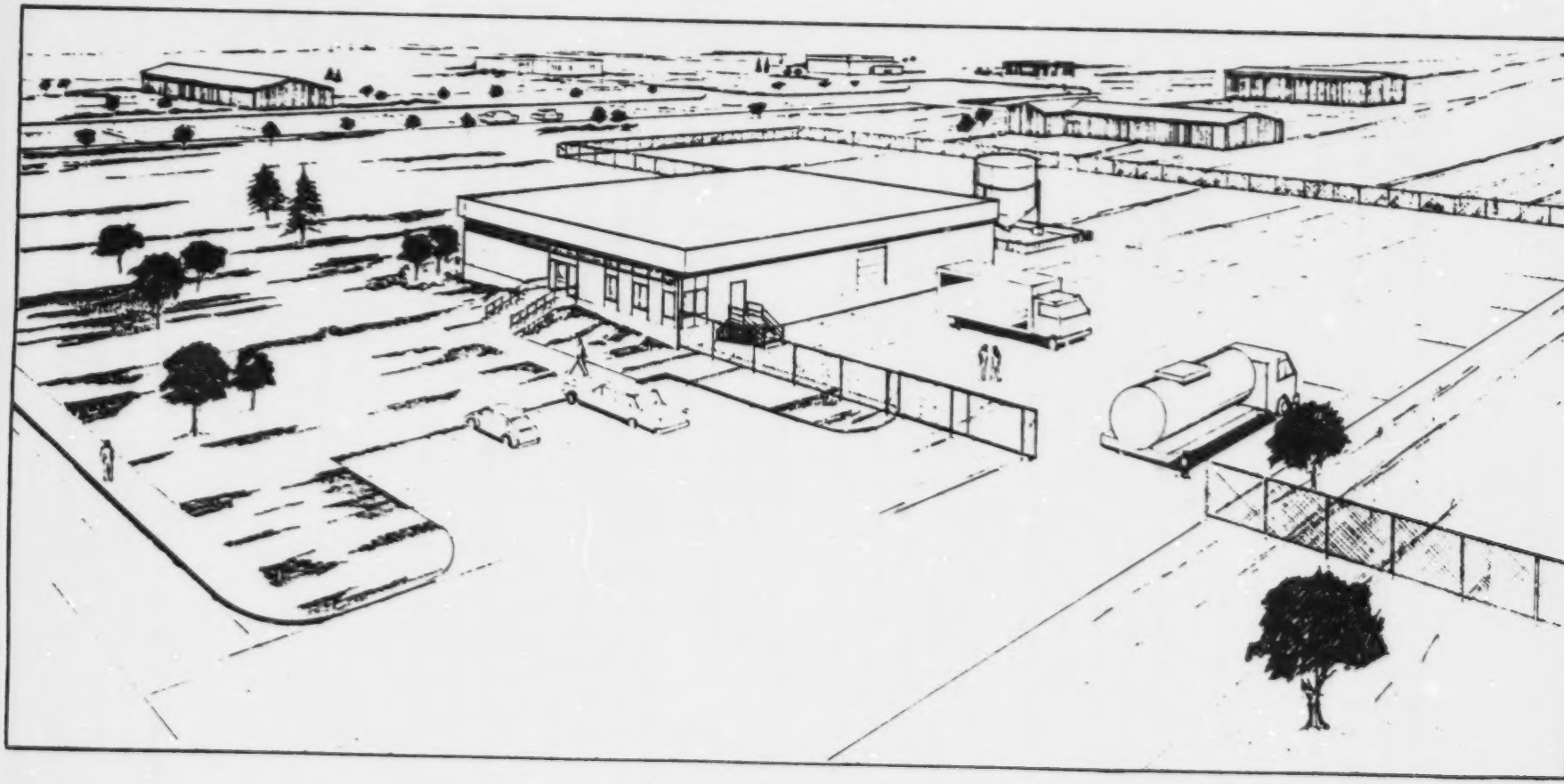

Figure 2-2 Commercial Transfer Station

It may also be necessary to develop smaller, mobile transfer stations to serve small, remote communities or to provide temporary services to meet specific needs (eg. household hazardous waste days). In these cases, transfer station requirements will be minimal and not subject to the proposed criteria.

2.4.2 Transfer Station Operation

Transfer stations will collect and receive hazardous wastes from regional industrial generators and other sources. Industrial generators will assume the responsibility of classification of the waste and must ensure the waste is properly packaged for transport in compliance with the Dangerous Goods Handling and Transportation Act. Transfer station staff will provide advice and technical assistance to generators on the proper packaging and shipping of wastes.

The facility will also provide similar services to regional institutions, municipalities, residents and any other generators of hazardous waste. Wastes received from these sources will likely be small quantities, individually packaged. It is anticipated that these wastes will require repackaging in compatible lots prior to transport, to meet the Dangerous Goods Handling and Transportation Regulations and the requirements of the receiving facility.

Wastes received at the facility will be inspected to ensure compliance with the Regulations. Repackaging of wastes will be conducted only to satisfy the Regulations for non-custody wastes or to combine compatible wastes into a more economic package for transport (i.e. bulking small quantity wastes such as paint residues). Waste reduction technology (eg. sludge dewatering) will only be considered in situations where alternative technology is not currently available in the region, where the quantity of appropriate waste is sufficient to warrant its consideration and the site provides adequate protection for the operation of the specific technology.

All wastes handled at the station will be properly packaged prior to storage. Wastes will be dispatched from the transfer stations as soon as possible depending on availability of capacity at the treatment centre and/or accumulation of sufficient quantities to warrant shipment.

3.0 SITE SELECTION PROCESS

3.1 Introduction

The Corporation has prepared a discussion document outlining the proposed process for the selection of potential sites for the development of the Manitoba hazardous waste management system (Latonas, 1988). This document has been distributed to a wide range of potential stakeholders for review and comment. The proposed process is dynamic and incorporates elements of local responsibility and "co-management", particularly in the selection of potential sites.

The following sections summarize the proposed process.

3.2 Objectives

The specific objectives of the site selection process are to:

- identify environmentally acceptable site alternatives;
- identify site alternatives that ensure protection of public health and safety;
- identify technically and economically feasible site alternatives; and
- seek and respond to public concern and input, both provincially and locally, in order to obtain support for the system's development in general, and local public support for site alternatives in particular.

These objectives recognize the need to incorporate and integrate environmental, technical, economic, and social criteria in the search for candidate sites.

3.3 Proposed Site Selection Process

Based on the experience of other jurisdictions, the site selection process is, perhaps, the single most difficult step in developing a hazardous waste management system. In addition, there is a recognized need to keep the public informed of siting initiatives and incorporate the direct input of the local public in the site selection process. In effect "public acceptance" constitutes a dominant factor in successfully siting a facility.

There is no "formula" which can guarantee the successful siting of a hazardous waste management facility. Experience elsewhere in North America suggests that the process can be extremely lengthy, expensive and unsuccessful if not conducted thoroughly and within an open public forum. Furthermore, it is impossible to prejudge the situation and anticipate all

potential concerns to be met in the siting process. Therefore, it is essential that the process be flexible, evolutionary and incorporate a proactive public and stakeholder participation component.

The proposed site selection process incorporates the experience gained from examining siting programs in other jurisdictions and the recommendations of the CEC (1987) derived through public hearings. Site selection for the Manitoba Hazardous Waste Management System will be conducted in a phased, "step-wise" fashion (Figure 3-1). Site selection for the central facility initially looks at the entire province and will, through progressive review and implementation of siting criteria, focus on smaller regions and local areas. The facility site selection criteria will be refined in each Phase with input from appropriate government agencies, stakeholders and the general public. Direct public participation in the development and application of the Phase 3 detailed siting criteria is a key feature of the process.

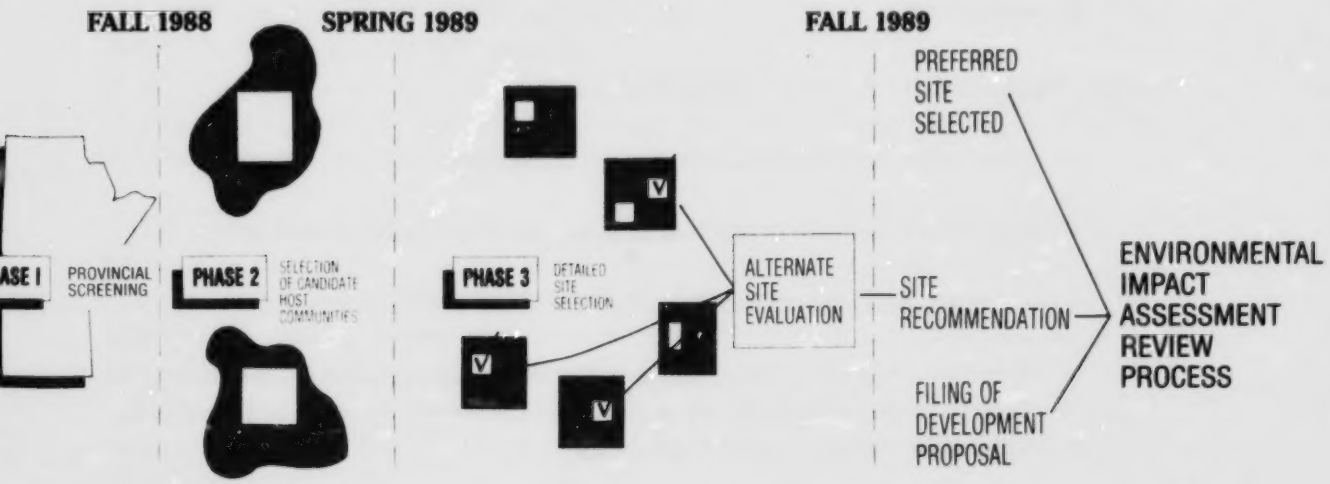

Figure 3-1 Site Selection Process

The process for selection of transfer station locations will be generally similar to, and conducted in parallel with, selection of the central facility site.

3.3.1 Phase 1: Site Selection Process and Criteria Development

Phase 1 is currently in progress and deals at the provincial level. Discussion documents prepared by the Corporation on development of the siting process (Latonas, 1988) and this document on site selection criteria constitute the major outputs of Phase 1. Phase 1 will be completed following stakeholder and public review and comment on these discussion documents.

The overall intent of Phase 1 is to lay the initial planning framework for activities related to

site selection. General response to the Corporation's discussion documents will be incorporated into the process so that it better reflects the needs, concerns and expectations of all potential stakeholders.

3.3.2 Phase 2: Selection of Candidate Host Communities

Phase 2 site selection activities will be conducted at the regional level. Information used in the selection of acceptable areas (provincial screening results) will be verified and more detailed information on these areas (candidate regions) will be compiled. This technical data collection and verification step will collect more detailed information on technical, environmental and socio-economic characteristics of the candidate regions. These data will be used to confirm the provincial constraint mapping information and provide additional information for subsequent detailed site selection initiatives.

Public participation and consultation programs will be directed at local communities within candidate regions. Local information sessions will be sponsored to provide community leaders and the general public with more detailed information on the site selection process and the subject generally. The objective of this step is to work at the community level to identify potential interest and/or support for facility development and concerns associated with it. Those communities expressing continued interest in the project which are confirmed to be in technically acceptable regions will be considered further as potential candidate host communities.

The final step in the Phase 2 program is the selection of candidate host communities. Those communities which meet the technical screening criteria and demonstrate continuing public support for the project will be invited to register as a candidate host community. It should be noted that no absolute commitment of support is required from a community at this stage. All candidate host communities are entitled to review all information pertaining to the development, particularly site specific information, prior to committing support for the project. Participation in the program is completely voluntary and communities are free to withdraw from further consideration at any time.

Those not selected, and those eliminated at earlier stages, may be evaluated as potential sites for transfer stations. A similar open and consultative process will be followed to select optimal locations for transfer stations.

3.3.3 Phase 3: Site Selection and Evaluation

The Phase 3 process includes the identification and ranking of site alternatives within candidate host communities. The first step in the detailed site selection process will be defining the boundaries of the candidate host communities and establishing a Community Advisory Committee in each. The Community Advisory Committees will have the responsibility of representing the public interest in future facility planning decisions and will

be encouraged to take an active part in all future public open houses and meetings.

The Advisory Committees will develop detailed community-specific site selection criteria in consultation with the Corporation. Workshops will be held to further refine criteria and identify weighting factors. All background information, including this document and response to it, will be available to the Advisory Committees. If several host communities are under investigation at this time, representatives of each Advisory Committee may be selected to participate in a final workshop where the common criteria and weighting factors will be discussed. These criteria, representing the new minimum siting requirements, will then be applied in the detailed site investigations.

Siting criteria and weighting factors developed through this process will include location sensitive technical, environmental, and land use factors only. Corporation staff will use these criteria to identify potential candidate sites within each host community. Pertinent environmental and land use constraints will be mapped on a series of overlays to identify areas where the finalized siting criteria can be met. Candidate sites will be selected in these areas and results will be presented to the public.

Specific information requirements will be identified and detailed site investigations will be conducted on each candidate site. Site investigations will include on-site surveys (eg. hydrogeological studies) to provide the level of detail required to make professional judgements with respect to relative site suitability for facility development. Results of detailed site investigations will be presented to the public and reviewed in detail with Advisory Committees prior to the final selection of the preferred site alternatives.

Prior to making a final site decision, it will be necessary to obtain confirmation of community support for the project. Host community participation in the site selection process was voluntary and communities were free to withdraw at any time. However, at this stage of project planning it is important that host communities provide a final declaration of public and community support. The Corporation will work through the Community Advisory Committees and local government councils to achieve this goal.

3.4 Final Site Selection and Regulatory Applications

This process will make it possible to identify and rank a set of alternate sites, all of which may offer acceptable development alternatives. The criteria and ranking system developed in consultation with Advisory Committees will provide the basis for ranking of sites on technical, environmental and land use merits. The Corporation will use this information in making its final site selection. Other considerations such as economics and judgement on

the maintenance of public support will be incorporated into the Corporation's business decision in finalizing the recommendations that it puts forward in its formal development proposal.

A recommendation will be made by the Corporation to its Board of Directors to submit a proposal to the Director of Manitoba Environment & Workplace Safety & Health, pursuant to The Dangerous Goods Handling and Transportation Act, for the development of a hazardous waste management facility at the preferred site. An alternate site(s), which meets all of the technical criteria, will also be identified if possible. This development proposal will outline details of the proposed facility and provide documentation of the site selection process. Although this application does not fall directly under the jurisdiction of The Environment Act, the process outlined in that Act for the preparation and review of an Environmental Impact Assessment is expected to be followed.

3.5 Summary

The proposed site selection process has a number of key features that should facilitate the task of identifying a facility site as outlined below:

- it follows a logical planning process for the identification of potential facility sites;
- site selection will be conducted in the public forum with all relevant information available to all interested parties;
- significant opportunities are provided for public input with the greatest emphasis placed on direct involvement by local communities; and
- participation in the program is voluntary and potential host communities can withdraw from consideration at any time in the program.

In summary, the Corporation believes that the major barrier to a successful siting program is the perception by the public that decisions directly affecting their well-being or quality of life are being imposed on them by outside vested interests. To avoid this perception, the Corporation has proposed a dynamic process involving the elements of local responsibility and "co-management". It is hoped that this model will prove effective and can be extended to the development and operation stages with direct, local community-based participation in the Corporation's activities.

4.0 PROVINCIAL SCREENING CRITERIA

The provincial screening process was developed to provide an efficient means of identifying "potentially acceptable" regions of the province for siting a hazardous waste management facility. The following sections outline the program objectives, criteria development and results of the provincial screening process.

4.1 Objectives

The provincial screening process is the first step in the search for acceptable sites for a fully integrated hazardous waste management facility. It is, in essence, the "qualification" of potentially acceptable regions where the probability of finding a suitable site(s) is greatest. This is achieved by identifying and eliminating areas of the province where facility development is clearly unacceptable for technical, environmental, land use or social reasons. Therefore, provincial screening criteria are "exclusionary", designed to eliminate the following:

- natural hazard areas which impose an unacceptable risk to facility integrity;
- areas which do not provide an acceptable degree of natural protection of sensitive environmental receptors; and
- areas where facility development is not technically feasible.

Economic criteria and assumptions based on the quantity and distribution of provincially generated hazardous wastes are not included in the provincial screening process. This exercise addresses only environmental and land use considerations to ensure that all potentially acceptable areas are initially identified.

4.2 Criteria Development and Application

Provincial screening criteria were developed following a review of site selection criteria applied in other jurisdictions. In addition, recommendations arising from the Clean Environment Commission public hearings on hazardous waste management issues in Manitoba were incorporated. Finally, the input of a wide range of provincial government departments was obtained. A general review of guidelines/regulations from other jurisdictions is presented in the Appendices, and reference is made to them throughout this report.

Each criterion represents a technical, environmental or land use constraint that is considered incompatible with facility development. These criteria, or constraints, were mapped as exclusion areas using a computer based geographical information system (Appendix C). This process allows the "overlaying" of several, or all, of the criteria to ultimately define those areas which are essentially free of facility development constraints. Through this process of elimination, potentially acceptable regions are identified. Future site selection activities will concentrate in these areas.

Each criterion included in the constraint mapping program is described in the following sections. The rationale for each criterion is presented. Sources of information for the mapping of criteria are also identified. Figure 4-1 presents the provincial base map used in the screening process. Major roads and urban centres are labelled to provide location references for the constraint maps included in this chapter.

4.3 Natural Hazard Avoidance Criteria

Areas which exhibit a natural hazard or present an increased occurrence of a natural hazard are considered incompatible with facility development. Development within these areas requires acceptance of an increased risk and the consequences arising from that decision. Although engineering design can compensate for most such risks, they may be prohibitively expensive and may not be capable of totally eliminating any increased risk. It should be noted that no true zero-risk situation exists in real life and that any activity must accept a certain level of risk. The criteria listed below were chosen to minimize the risks posed to a facility by natural hazards.

Criteria

(1) Flood Plains: Areas prone to flooding present a natural risk component to facility integrity and operation, as well as adding a potential environmental contamination pathway. For this reason, facility development will not be considered within a defined flood risk area, or an area which cannot be adequately protected from potential flood damage.

Flood risk areas have been identified for selected communities and areas of the province under the Canada-Manitoba Flood Damage Reduction Agreement. Flood risk areas defined under this program are typically set at the 100-year flood event level. The 100-year flood plain is defined as that area that would be inundated by a flood having a one percent chance of occurring in any given year. The Canada-Manitoba Flood Damage Reduction Program is administered by the Department of Natural Resources, Water Resources Branch, and by Environment Canada.

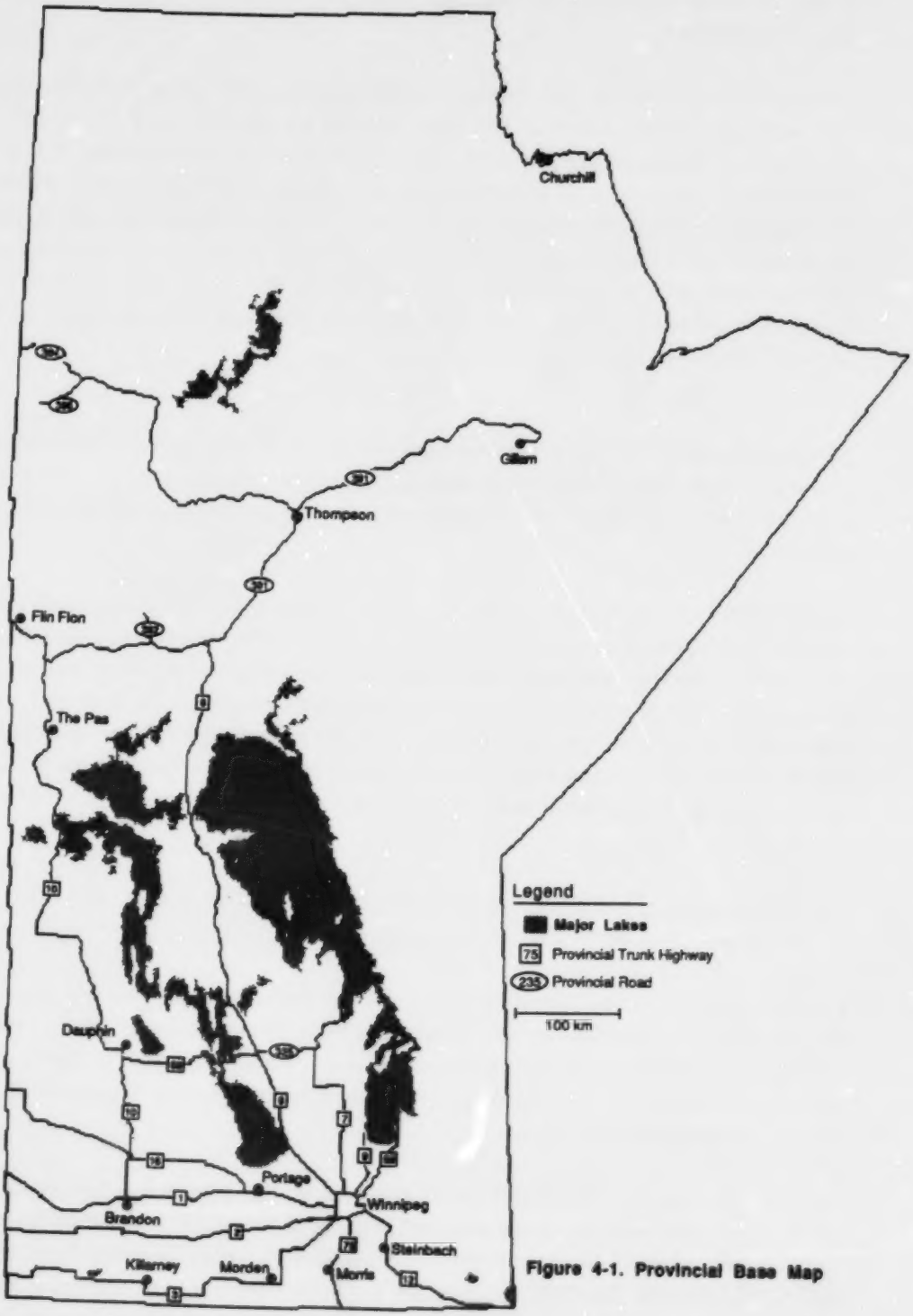

Figure 4-1. Provincial Base Map

Maps, depicting the provincial flood risk areas are available from Manitoba Water Resources Branch.

Existing 100-year flood risk information was obtained for determining provincial flood plain exclusion zones. However, given the scale of presentation, only the Red River flood plain is visible at the provincial level (Figure 4-2). It is recognized that this information is not complete, particularly for rural areas. Therefore, a more detailed investigation will be undertaken as part of Phase 2 to ensure flood risk is adequately addressed at the regional and local levels. It should also be noted that the Red River 100-year flood plain is conservative. It is established 30 cm (12 inches) above the expected flood level to accommodate potential wave action on inundated lands (pers. comm. F. Barlishan, 1988).

(2) Seismic Risk Areas: Earthquake events can cause extreme damage to surface facilities and can impact both the geologic and hydrogeologic characteristics of the site . Therefore facility development in earthquake or seismic prone areas will not be considered.

Energy, Mines and Resources Canada, Geological Survey of Canada have conducted a national evaluation of earthquake occurrence and risk. The national earthquake risk map was obtained and key individuals in the department were consulted. Information provided by Energy, Mines and Resources Canada indicates that Manitoba is very stable, geologically. Minimal seismic activity has been detected in Manitoba this century, and the entire province is within "Zone Zero" of the seismic zoning maps of the National Building Code of Canada (pers. comm. B. Wetmiller, 1988).

Therefore, provincial exclusion zones are not justified based on seismic risk.

(3) Karst Terrain: Carbonate (limestone and dolomite) bedrock formations are prone to the formation of cavities by the solution activity of groundwater flow. As a consequence, these areas are geologically and hydrogeologically complex, and present a potential risk of subsidence. For these reasons, facility development will not be considered in karst terrain.

Karst terrain has not specifically been mapped in the province. However, the incidence of karst features can be assumed in areas of limestone or dolomite bedrock outcrops characteristic of the northern Interlake district. Also, potential karst areas may be identified as provincial groundwater pollution hazard areas. Therefore, maps depicting bedrock outcrop areas (Figure 4-8) and aquifer pollution hazard areas (Figure 4-3) are assumed to represent the primary karst potential

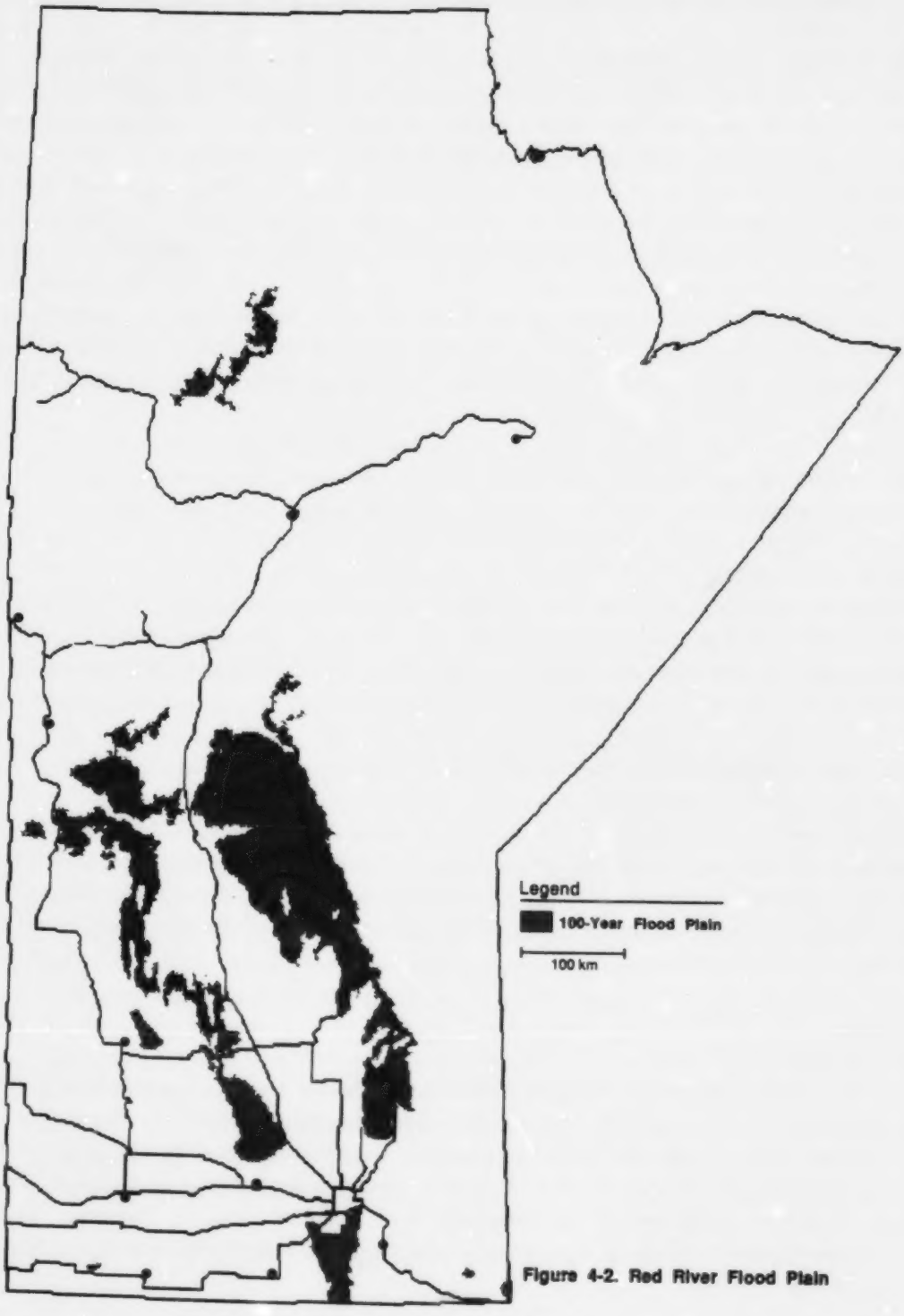

Figure 4-2. Red River Flood Plain

areas in the province. The potential existence of karst terrain will be evaluated in more detail for specific areas (if necessary) in Phases 2 and 3 of the site selection process.

Application of tornado risk zones was also considered for the provincial screening process because of the potential for surface facility damage arising from severe tornadoes. Environment Canada, Atmospheric Environment Service has produced two documents addressing the frequency of occurrence of tornadoes and the associated annual average percentage risk of tornado damage for Manitoba. These estimates are based on the recorded history of tornado occurrences between 1950 and 1982 (Raddatz et al., 1983, Newark, 1983). Southern Manitoba experiences the second highest incidence of tornadoes in Canada. The average annual frequency of tornadoes in southern Manitoba ranges from 0.4 to over 1.2 per 10,000 square kilometer area. The predicted average annual risk of tornado damage associated with these occurrences ranges from less than 0.0005 to 0.05 percent (Newark, 1983).

The tornado risk zones identified for southern Manitoba cover an extremely large area, but these risk zones are not associated with physical features that can be avoided by facility location. The probability of tornado damage occurring within a 2.56 km^2 (1 mi^2) area in the highest probability area in southern Manitoba is 0.17 percent. The recurrence interval of damage would be 588 years, significantly less than the 100-year recurrence interval used for exclusion of flood prone areas. Therefore, exclusion of tornado risk areas is not considered appropriate. However, tornado risk information will be considered further in the Phase 3 site investigations and facility design will address this risk.

4.4 Environmental Protection Criteria

Areas of unique and significant environmental value and areas which are sensitive to contamination are not considered compatible with industrial development represented by a hazardous waste management facility. In addition, development within these areas would not be socially acceptable. The following criteria outline exclusion areas based on environmental considerations.

Criteria

(1) Groundwater Pollution Hazard Areas: Groundwater resources, particularly potable water aquifers, represent a significant and valuable natural resource in the province of Manitoba. Industries with a potential to increase the risk of groundwater contamination should be sited to protect ground water supplies and provide ample time for containment and remediation of pollutant spills. Therefore, facility development will not be considered in areas where a known aquifer pollution hazard exists.

The Department of Natural Resources, Water Resources Branch has mapped, on a provincial scale, aquifer pollution hazard areas. These areas include the following:

- o aquifers which are prone to pollution by infiltration of pollutants from the surface;
- o townships where the potential for damage to a fresh water aquifer is very high; and
- o current and potential significant municipal water supply wells or well fields.

Aquifer pollution hazard areas are presented in Figure 4-3 (Rutulis 1986). This information provides the basis for exclusion of areas on the potential for, and/or consequence of, groundwater contamination.

More detailed criteria are proposed for the identification of potential sites further on in this report. However, site specific information will ultimately be required for the evaluation of potential facility sites.

(2) Provincial Parks: Provincial Parks have been established for the protection and enjoyment of Manitoba's natural resources. Facility development is considered incompatible with provincial parks and these areas are therefore excluded from consideration in the facility siting program.

Maps and information provided by the Manitoba Parks Branch were used to identify appropriate classifications and locations for the exclusion of provincial parklands. Provincial parkland exclusion areas are presented in Figure 4-4 (Parks Branch, 1986). All classifications of provincial parklands, including wilderness, natural, heritage, recreation, wayside and special use parks will be excluded from consideration in the siting process. However, because of the small land area associated with some park classifications, only wilderness and natural parks are depicted in Figure 4-4. All other parklands will be included in the regional-level site selection process.

(3) Wetlands: Wetlands are defined as areas characterized by deep organic deposits and poor drainage. These areas are generally unacceptable for facility development because of a high groundwater table, the potential for seasonal flooding and poor foundation characteristics. Therefore, wetlands will be excluded from consideration in the site selection process.

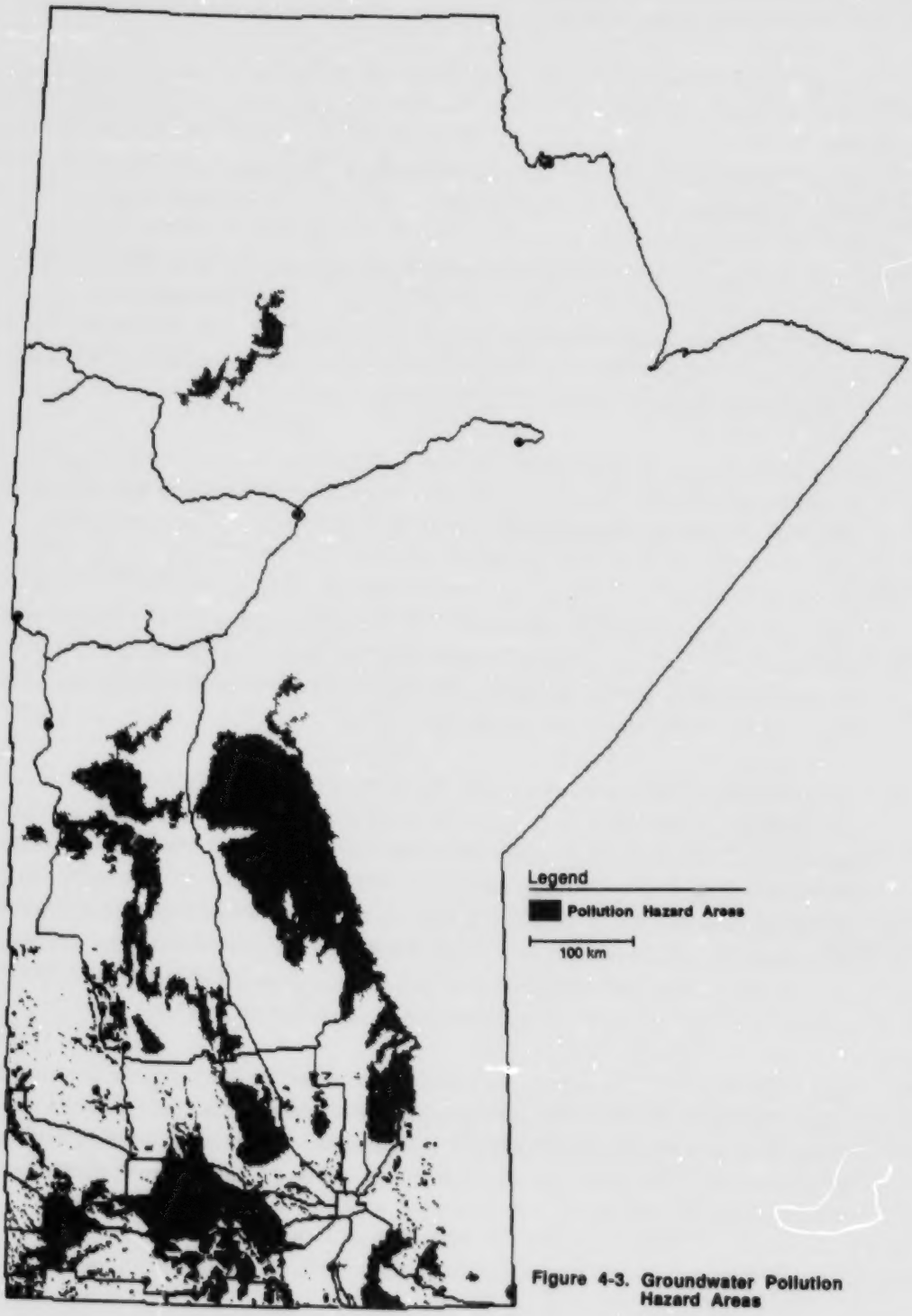

Figure 4-3. Groundwater Pollution Hazard Areas

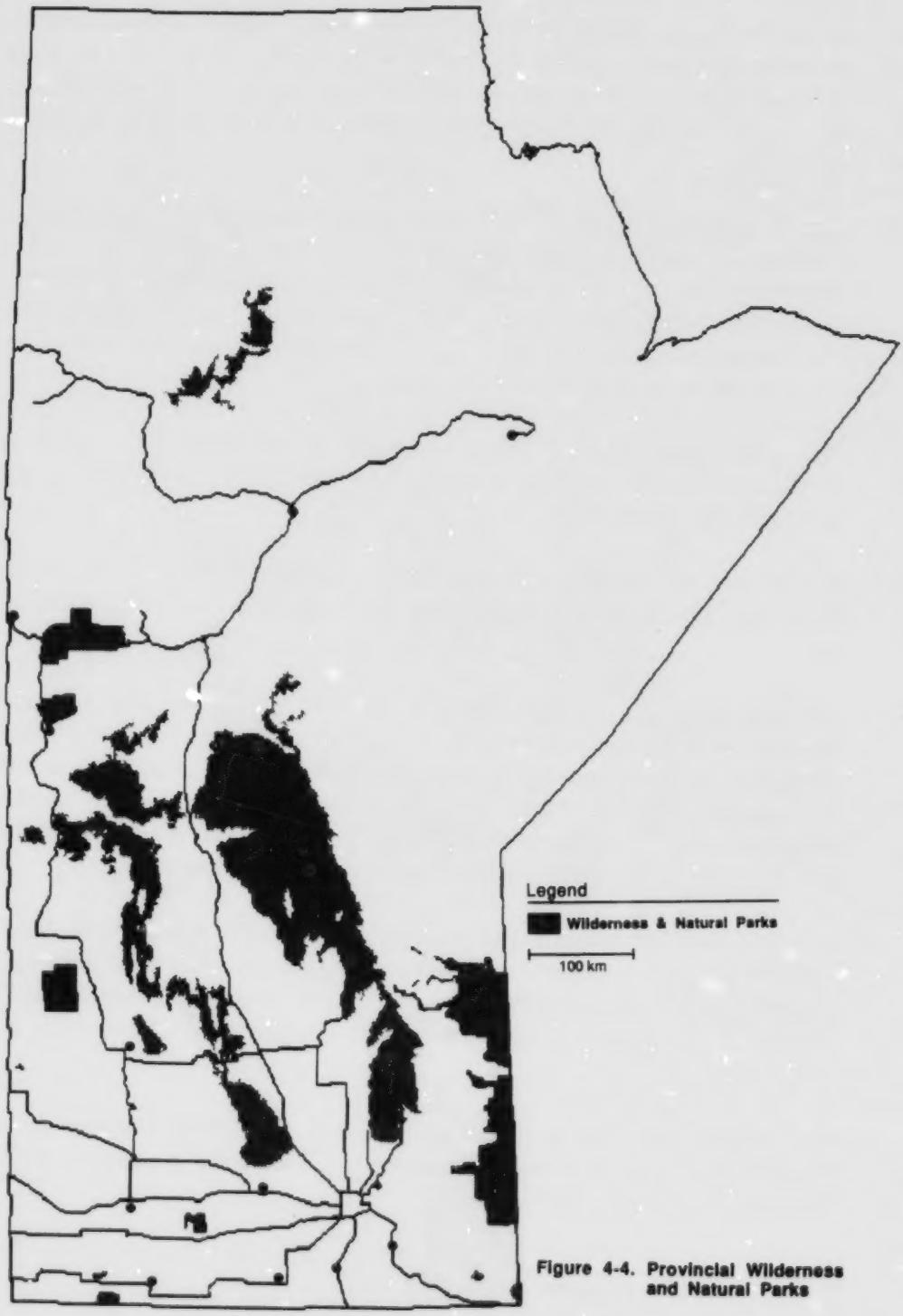

Figure 4-4. Provincial Wilderness and Natural Parks

Organic surficial deposits in Manitoba have been mapped by the Department of Energy and Mines, Mineral Resources Division (1981). Organic deposits are defined as marsh, swamp, fen, and bog deposits up to six metres in depth which are prone to seasonal flooding. This source outlines the major provincial wetlands as surficial organic deposits and these areas are mapped as exclusion areas for facility siting Figure 4-5).

(4) Class 1 Agricultural Lands: Canada Land Inventory (CLI) Class 1 agricultural lands represent the potentially most highly productive lands in Manitoba. These areas also support, or are capable of supporting, significant specialty crop production not common elsewhere in the province. Because of their inherent agricultural capability, these areas are considered of prime importance to the agricultural productivity of the province and are excluded from consideration in facility siting.

Agricultural capability and use will be investigated in more detail at the regional level. Additional criteria are proposed in Section 5 to avoid conflict, to the extent possible, with agricultural production.

The Canada Land Inventory Soil Capability for Agriculture, 1:250,000 map series (CLI, 1974), was used as the basis for excluding Class 1 agricultural land (Figure 4-6).

(5) Ecological Reserves and Wildlife Lands: Designated or proposed ecological reserves are areas which represent characteristic and/or unique habitat associations. Some of these sites are recognized on an international basis as part of the United Nations International Biological Program. Ecological Reserves, along with provincially designated Wildlife Management Areas, have been set aside for the preservation of specific ecological components and/or habitat resources in the province.

Ecological Reserves (existing and proposed) and Wildlife Management Areas are excluded from consideration in this siting process. All large units which are mappable at provincial scale are presented as exclusionary areas (Figure 4-7). Smaller units, not included in this map, will be identified and excluded from consideration at the regional level.

The selection and mapping of Ecological Reserves and Wildlife Management Areas (Figure 4-7) is based on information provided by the Manitoba Department of Natural Resources (pers. comm. R. Thomasson).

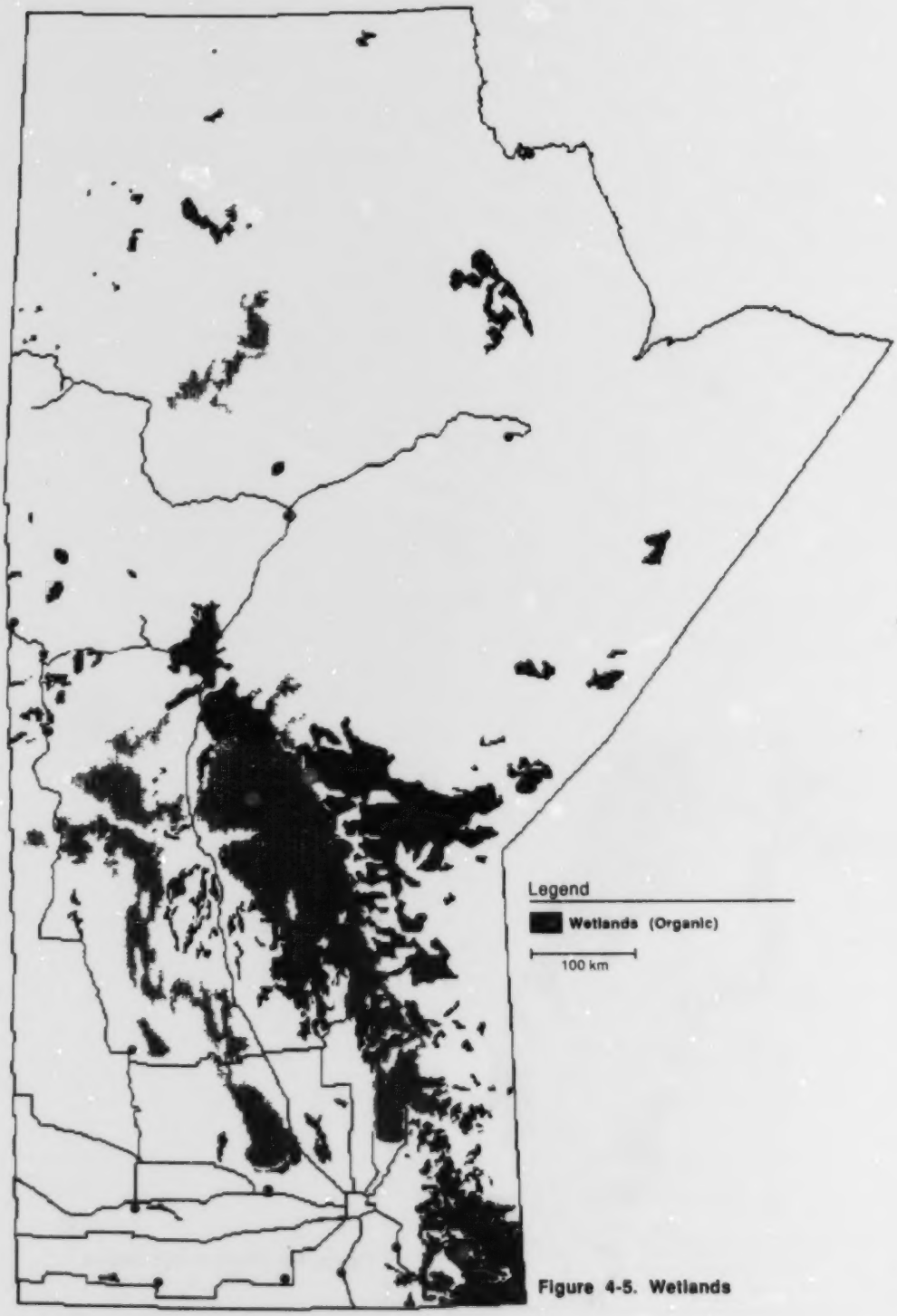

Figure 4-5. Wetlands

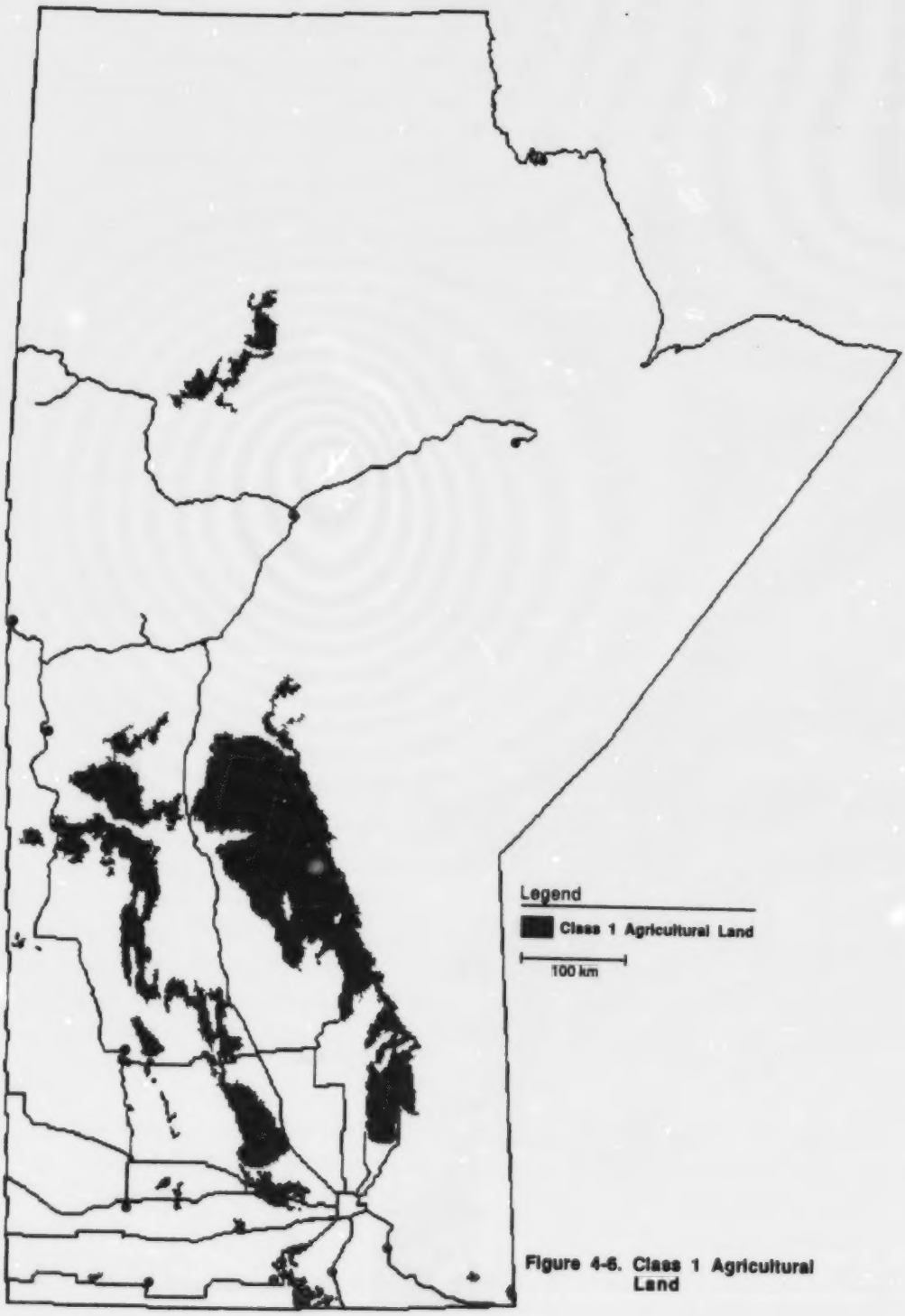

Figure 4-6. Class 1 Agricultural Land

Figure 4-7. Ecological Reserves and Wildlife Lands

4.5 Technical Criteria

The long term operation and eventual decommissioning of the site should be considered in the site selection process. The site, and surrounding area, should provide opportunities for the establishment of a sensitive and reliable monitoring system. In particular, the site should have good potential for the establishment of an effective groundwater monitoring program. Local terrain and surficial geology should also provide a natural barrier to contaminant movement and allow for cost effective remediation in the event of site contamination.

Criteria

(1) Bedrock Outcrop Areas: Bedrock outcrop areas include extensive areas of precambrian rock in eastern Manitoba and smaller areas of carbonate rock outcrop in the north-central part of the province. These areas are characterized by high rates of surface water runoff and often complex geology which is difficult to monitor on an economic basis.

Hazardous waste facilities should be developed in areas which provide a natural barrier to the transmission of contaminants to the environment. This "natural barrier" should be amenable to monitoring and remediation. Bedrock outcrop areas do not provide these features and are therefore, excluded from consideration. This criterion is consistent with the criteria generally applied by others and the preliminary engineering work done by the Corporation.

Bedrock outcrop areas have been mapped by the Department of Energy and Mines, Mineral Resources Division (1981). This information, presented in Figure 4-8, forms the basis for mapping provincial bedrock exclusion areas.

(2) Permafrost: Much of northern Manitoba lies within continuous permafrost or discontinuous permafrost zones. Soils within these zones are, or have the potential to be, permanently frozen.

Permafrost regions pose specific engineering design problems for facility development. Alteration of the permafrost regime can result in unstable soil conditions and pose a risk to facility integrity. In addition, it may not be possible to adequately characterize the site or predict potential subsurface transport of contaminants in permafrost areas. For these reasons, areas of continuous permafrost are excluded from consideration. Development within the discontinuous permafrost region is not recommended. Detailed evaluations, on a regional basis would be required to identify the extent of permafrost and its potential effect on facility siting

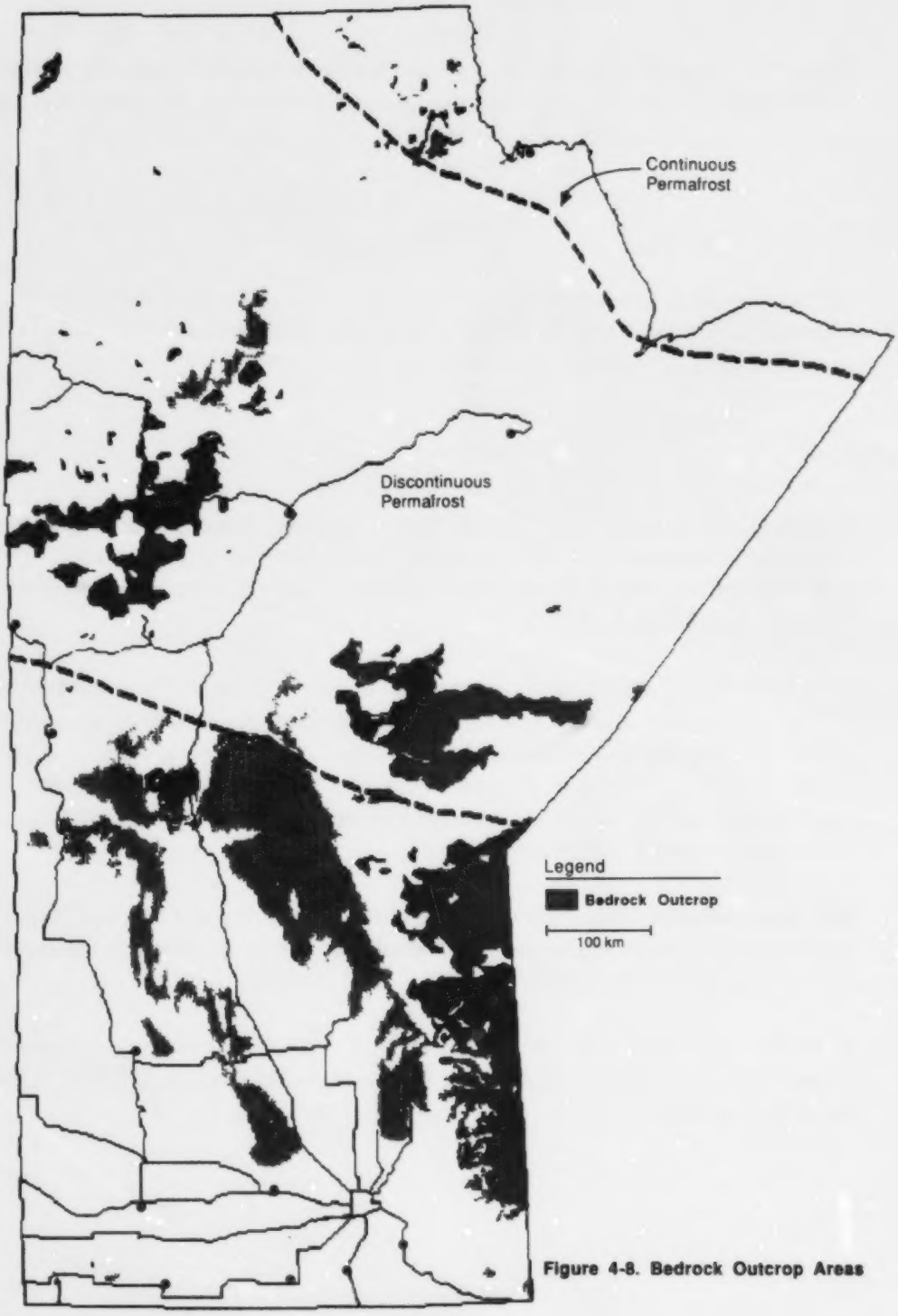

Figure 4-8. Bedrock Outcrop Areas

and servicing. Therefore, facility development will not initially be considered within the discontinuous permafrost zone.

Permafrost zones mapped by the Geologic Survey of Canada (1969) are shown in Figure 4-8. Isopleths depicting the general distribution of continuous and discontinuous permafrost are presented.

4.6 Land Use Criteria

The intent of the land use criterion is to identify, on a provincial basis, significant landholdings which are dedicated to alternate land uses either incompatible with facility development or outside the control of provincial regulation.

Criteria

(1) Federal Lands: Federal lands include Indian Reserves, National Parks, and lands owned by federal departments or agencies. Some of the latter own or have control over relatively large tracts of land, including military reserves, research establishments and correctional institutions.

Federal lands are dedicated to alternate land uses considered incompatible with facility development and are excluded from consideration. In addition, hazardous waste management is a provincial responsibility. Development on federal lands would involve another level of government and may require project review and approval through the federal environmental assessment review process. This could significantly delay the site approval process.

The major federal landholdings, consisting of Indian Reserves and National Parks are shown in Figure 4-9. Smaller federal landholdings will be identified at the regional level and excluded at that point.

It should be noted that in the event that federal authorities recommended consideration of a specific location, the Corporation could include it in the detailed site evaluation step.

Figure 4-9. Federal Lands

4.7 Provincial Screening Results

Areas that are considered unsuitable for facility development were identified from published sources and shown in a series of maps in this section, based on four categories of criteria. These include:

- natural hazard;
- environmental protection;
- technical; and
- land use categories.

All areas considered unsuitable or incompatible with facility development under these general categories are initially excluded from consideration as candidate areas for a facility site.

Figure 4-10 presents a composite map showing all excluded areas, according to the above four categories. However, information used to prepare the map is not of uniform detail or quality for all regions. For example, more detailed information is available for southern Manitoba than the north. Therefore, caution must be exercised in interpreting this figure. The provincial screening exercise was conducted on a broad scale, and it is possible that "pockets" of suitable terrain, large enough to locate a facility, may exist within excluded zones. However, it should be recognized that the probability of finding potentially suitable sites is much higher in the remaining areas.

Detailed investigations will focus on those areas which are essentially free of constraints as identified through this process. Criteria proposed for application on a regional basis are presented in Chapter 5.

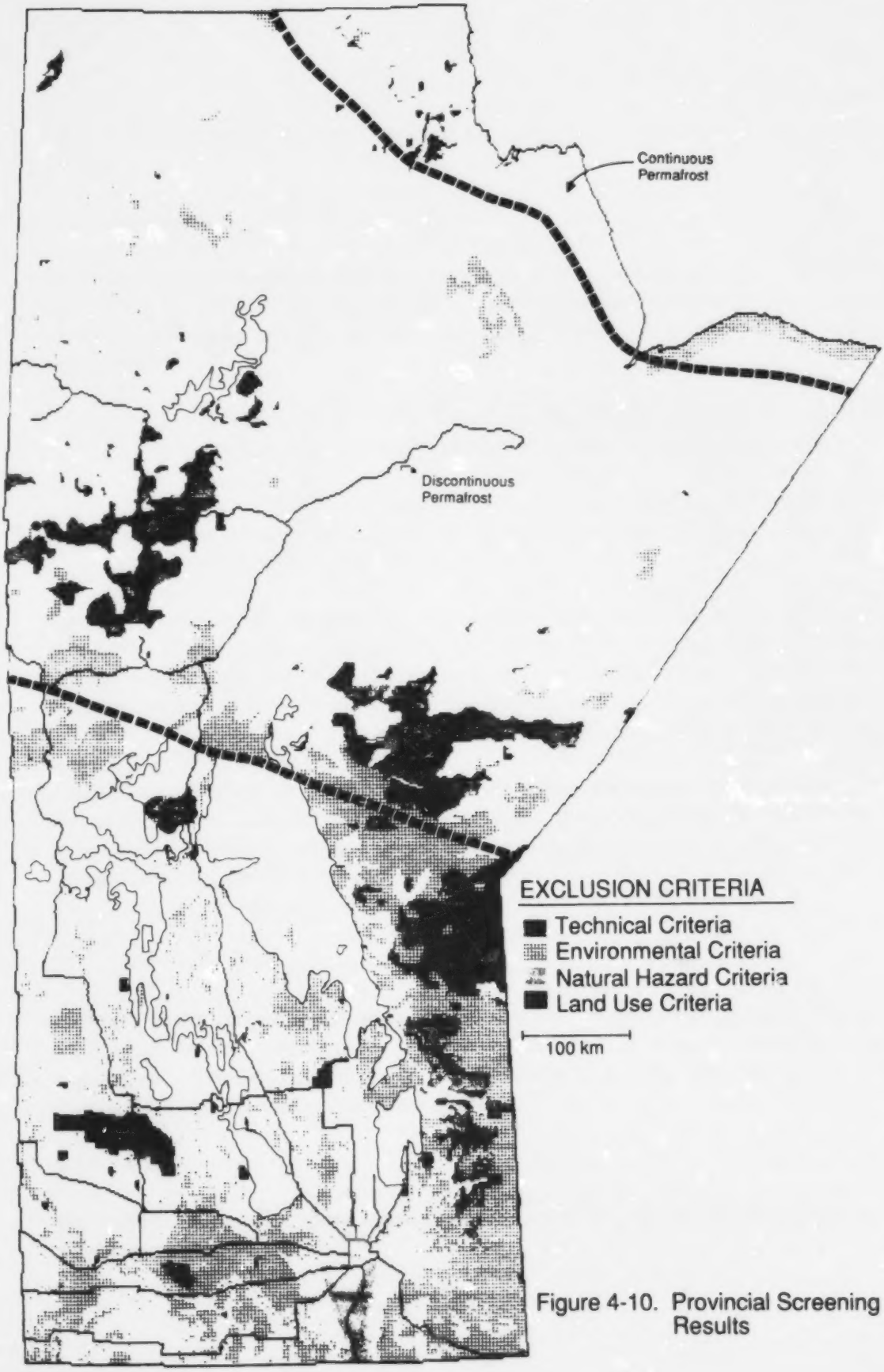

Figure 4-10. Provincial Screening Results

5.0 SITE SELECTION CRITERIA - CENTRAL FACILITY

5.1 Introduction

The following sections present proposed criteria to assist in the identification of potential sites. These criteria will be applied within "acceptable areas" as identified through the provincial screening process. These "acceptable areas" must have the following characteristics:

- o be relatively free of natural hazard, environmental, technical and land use constraints as determined through the provincial screening process; and

- o an informal indication of interest, and/or a formal request to be included in the site selection process, should be expressed by the principal urban and/or rural communities involved.

The intent of this section is to define key considerations and propose criteria that will assist in the identification of potential sites. The information presented is intended to stimulate discussion on site selection issues and provide background material for the justification of the proposed criteria. Criteria applied in other jurisdictions are presented in the Appendices for reference.

A parcel of land which meets all of the proposed criteria will be considered an acceptable site, subject to verification of site specific resources. This "acceptability" is based only on technical, environmental and land use factors. A detailed evaluation of each site will be required to verify its acceptability and rank alternatives.

5.2 Technical Considerations

Technical criteria address the technical requirements of facility development and operation which must be considered in site selection. These include access, services and land requirement. Site selection criteria (or considerations) associated with facility technical requirements are discussed in the following sections.

5.2.1 Access

Description: Access refers to the existence and/or availability of road and rail transportation networks in a given region.

Criteria: The following criteria are proposed:

(1) The site must be within reasonable distance (25 kilometres recommended) of a paved provincial trunk (or equivalent) highway.

(2) Preferably, the site will have alternate road access and be in an area that is, or can be, economically serviced by rail.

Justification: Road access is essential for facility construction and operation. The site must be serviced by well constructed and maintained roads not subject to significant seasonal weight restrictions. In addition, these routes must be designated as dangerous goods truck routes. Under the Highway Traffic Act, all provincial numbered highways are designated truck routes and, at present, dangerous goods routes are implicit to truck routes. Therefore, proximity to an existing provincial trunk (or equivalent) highway is an essential requirement of the site.

The length of new facility access road(s) serving potential sites should be minimized to reduce overall project capital and operating costs and minimize environmental and land use impacts. A maximum distance from existing highways of 25 kilometres is recommended. It is anticipated that this restriction will focus siting activity in those areas already well serviced by provincial highways and will not severely limit areas available to the siting process. It should be noted that the 25 kilometre criterion is viewed as being conservative. The cost of providing this fundamental service is a significant economic factor which must be included in the final evaluation and ranking of site alternatives.

It is recommended that the site be serviced by more than one access road. Ideally, these roads will not rely on the upgrading of existing public roads and provide direct private access to the facility. These options will help minimize local traffic along the facility access road(s) and provide greater flexibility for emergency response planning.

Rail access is desirable as it may provide the most economical transportation alternative for bulk quantities of wastes. However, the need for rail access has not been demonstrated at this time. Rail access is considered desirable, but not essential, for facility operation. Therefore, it is recommended that the site be located within an area which can be economically serviced by rail or in which existing rail sidings are accessible.

Distance to markets is not included as a consideration in the evaluation of site access at this time. However, it will be necessary to address issues of transportation risk and transportation economics prior to the selection of a preferred site. Since these items will require more accurate information on the quantities and distribution of hazardous waste generated in the province, it is more appropriate to address them in detail as part of the Phase 3 investigations when more specific information is available.

Several States including New Jersey, Oregon, Minnesota, and Pennsylvania (Appendix A) have developed access recommendations in their siting criteria. These criteria are designed to ensure safe and economical access to facilities. The Ontario Waste Management Corporation included an evaluation of serviceability and transportation risk in the evaluation of alternate sites. The proposed access criteria are consistent with criteria adopted in other jurisdictions for the initial identification of potential sites.

5.2.2 Services

Description: Services refers to the availability of basic industrial site requirements including natural gas, electric power, telephone, water etc. For site selection, the most critical service requirements are the local availability of secure sources of natural gas, electric power and water.

Criterion: The following criterion is proposed:

(1) The site must have an acceptable source(s) of natural gas, electric power and water. Alternatively, these services must be available regionally, at reasonable cost.

Justification: Operation of the facility will require a reliable source of natural gas, electric power and water. Based on the service requirements defined for two integrated hazardous waste treatment facilities (Swan Hills, Alberta and the OWMC facility) the preliminary estimate of these basic services is outlined below:

- Natural Gas — 10 gigajoules/hour
- Electric Power — 2 MVA
- Water — 50 m^3 (50,000 litres)/day

Initially, the facility will not require the full service capacity. However, it is essential to ensure this capacity is available locally to ultimately meet the long term needs of the facility.

The natural gas requirement can be supplied from existing 150mm (six inch), or larger, trunk lines. Electric power can be supplied from the existing 12 kV rural distribution network. It is anticipated that site runoff, on-site water treatment and recycling will meet much of the required process water demand. However, access to a suitable surface water source, groundwater aquifer or existing community water supply will be required for potable water and process make-up water.

Security of supply is a desirable feature in order to minimize the potential for disruption of operations at the site. Access to alternate sources of supply may be a requirement of key

process technologies used at the facility. These considerations will be addressed in detail during the conceptual engineering design.

Access to telephone, and sewer would be an advantage. However, these services can be supplied at the time of site construction and are not considered essential for site selection.

5.2.3 Land Requirement

Description: Land requirement refers to the land area retained in ownership by the Corporation for the purpose of constructing, maintaining and operating a facility. The land requirement does not include the total area over which the Corporation may wish to arrange for planning and development control for the purpose of maintaining a suitable buffer zone.

Criteria: The following criteria are proposed:

(1) The minimum land requirement is 65 ha (160 acres) and an area of 130 ha (320 acres) is recommended.

(2) Potential sites will be preferentially located on provincial crown land.

Justification: The facility will occupy a relatively small land area. Based on integrated facilities developed in Alberta and proposed in Ontario, a plant site area of from 5 to 20 ha (12 to 50 acres) is required. Additional land is required to accommodate any future facility expansion, maintain direct development control over immediately adjacent lands and provide ample room to establish on-site monitoring systems. Also, a relatively large land area will allow considerable flexibility for placing specific components on the most suitable portion of the site. Therefore, a minimum land area of 65 ha (160 acres) is considered essential and a larger site (130 ha or 320 acres) is desirable.

The development of a facility to meet provincial hazardous waste management requirements on crown land offers both economic and social advantages. The land may be available to the Corporation at a lower real cost than private lands and security of ownership and land use control over adjacent "buffer" lands may be easier to maintain. In addition, since potential direct impact on private landholders would be minimized, overall public acceptability of the project may be enhanced.

Development on provincially owned land is considered desirable and will be given priority. The Crown Lands Division of Natural Resources will be consulted in this regard to determine which provincial crown land allocation categories would be potentially suitable for consideration in the regional site selection process.

As indicated, it is advisable to maintain land use controls over adjacent lands to prevent the encroachment of incompatible land uses. It is recommended at this time that this control be

exercised, on private lands, through the purchase of surface easements or restrictive covenants on surrounding property. This option will allow adjacent lands to remain in private ownership and encourage the maintenance of existing land use. The areal extent of this control will be determined on a site specific basis, giving consideration to existing and proposed adjacent land uses.

5.3 Physical and Environmental Criteria

Criteria are proposed in the following sections to address location sensitive aspects of the physical and natural environment. A description of each physical and environmental component is presented along with the associated criteria and justification.

5.3.1 Geology

Description: Geology refers to bedrock geology and the characteristics of bedrock geology which may ultimately affect facility siting.

Criteria: The region must exhibit bedrock geologic characteristics that are consistent with facility development. The following specific criteria are proposed:

(1) Facility development will not be allowed in karst terrain; and

(2) Facility development will not be allowed in active fault areas or areas prone to seismic activity.

Justification: Bedrock geology must be considered to ensure that a secure and acceptable geological foundation is provided for the site. In addition, the site, including the underlying bedrock, must be amenable to characterization and monitoring using economically practical techniques and be essentially free of natural risk.

Karst terrain is found in areas where carbonate bedrock (limestone and dolomite) is located at or near the ground surface. These areas are prone to the formation of cavities through solution action of water on the bedrock. These cavities provide for the rapid transmission of groundwater and can generate a hydrogeologic regime which is difficult to model or monitor. In addition, in extreme cases, large caverns can be formed which may lead to a slumping of the ground surface (sink holes).

Seismic activity, e.g., an earthquake can, in extreme cases, cause severe damage to surface structures. Manitoba is considered stable and no active Holocene faults have been identified. However, it is prudent to verify local seismic risk and ensure that design and construction of surface structures address this risk.

The U.S. EPA prohibits the development of new treatment, storage and disposal facilities within 61 metres of a fault which has been active in recent geologic (Holocene) time. In addition, the existing and proposed siting guidelines exclude development in geologically complex areas which cannot be adequately characterized or monitored. Karst areas are included in the definition of geologically complex areas. Most States have adopted these or similar siting restrictions (Appendix A). Consideration of seismic prone areas was included in the Alberta site selection process and British Columbia has developed siting criteria which exclude development over Holocene faults (Appendix B).

Karst terrain and seismic prone areas were applied as exclusion criteria at the provincial screening level. However, information sources defining the limits of these geologic features are not considered sufficiently accurate for detailed site selection. These areas are unacceptable for facility development and therefore, it is important to re-evaluate these criteria at the regional and local level.

5.3.2 Surficial Geology and Topography

Description: Surficial geology refers to the material deposited on top of the bedrock and the characteristics and features (i.e. topography) associated with that material which are important to consider in facility siting.. In Manitoba, surficial deposits can vary from rolling deltaic sands (Carberry sandhills), to deep lacustrine clays found in the flat glacial lake beds characteristic of the Winnipeg area.

Criteria: Surficial geology must provide a secure base for construction and provide a natural barrier to the potential contamination of groundwater resources. The following criteria, which reflect acceptable surficial geological features for facility development, are recommended:

(1) Surficial materials must consist of either clay, till or a combination of the two. Development will not be considered in areas dominated by sand, gravel or organic deposits.

(2) Surficial materials must be of sufficient thickness and permeability to meet the groundwater protection criteria outlined in Section 5.3.4.

(3) Facility development will not be considered in areas of unstable terrain including areas prone to mass erosion, subsidence or landslides.

(4) Facility development will avoid, to the extent possible, steeply rolling land where slopes exceed 15 percent.

Justification: The stability and permeability of surficial materials are essential criteria to be evaluated in site selection. Although the facility will be designed to protect the groundwater regime, construction within an area that exhibits a suitable surficial geology will provide an additional measure of protection. Surficial materials must provide a relatively homogeneous medium to permit the detailed characterization of site hydrogeologic resources and establishment of a groundwater monitoring system. In addition, surficial materials should be amenable to remediation using conventional methods to minimize the future financial liability associated with facility decommissioning.

Regions that are underlain by reasonably thick and relatively impermeable surficial deposits (i.e. thick glacio-lacustrine clay or glacial till) will be considered essential for site development. Sand and gravel deposits will be avoided because of the high permeability of these materials. The relatively high groundwater velocities characteristic of these deposits increase the risk of groundwater contamination.

Areas prone to mass erosion, subsidence or landslides are unacceptable for facility development. The long term integrity of the site must be considered to ensure the security of treated residues stored on the site. Consideration of site topography is also important to avoid areas where surface water runoff is rapid. Steeply rolling land, where grades exceed 15 percent, is considered undesirable. Avoidance of these areas also has the added advantage of minimizing site disturbance during construction (grading) thereby reducing site preparation costs.

These proposed criteria are consistent with those developed in other jurisdictions. The U.S. EPA recommends avoidance of unstable lands dominated by permeable surficial materials and several States (eg. Pennsylvania and Virginia) have developed topographical (slope) siting constraints (Appendix A). Development in areas of relatively impermeable surficial materials and avoidance of steep slopes were recommended by the Manitoba Clean Environment Commission following review of submissions at public hearings.

5.3.3 Surface Water

Description: Surface water refers to the presence and distribution of surface water bodies including streams, rivers, ponds and lakes and the quality of water contained in those bodies. Aspects of surface water hydrology, which are important to consider in the context of site selection, include regional surface water distribution, drainage patterns, surface water use and flood risk. In addition, water quality is a consideration which will be addressed in the site selection process. Selected watersheds in Manitoba can be designated under the Manitoba Surface Water Quality Objectives (ME&WSH, 1988) as "Exceptional Value". This designation defines those watersheds for which a particular water quality concern exists.

Criteria: The following criteria are proposed to address those aspects of surface water hydrology and quality which warrant consideration in facility siting:

(1) Facility development will not be considered within a 100-year flood plain unless alternate sites are not available and it can be demonstrated that the facility can be designed, constructed, operated and maintained to prevent the release of contaminants in quantities sufficient to significantly impact water quality in the event of a flood.

(2) Facility development will not be considered within 500m of a lake or continuously flowing stream or river.

(3) Facility development will not be considered within a provincially designated "Exceptional Value" watershed as defined in the Surface Water Quality Objectives (ME&WSH, 1988).

(4) Facility development will not be considered within a defined watershed which directly feeds an on-stream reservoir used for a community water supply or within that portion of a watershed which feeds an off-stream reservoir used for a community water supply.

Justification: The proposed surface water criteria recognize the importance of surface water as a potential pathway of contaminant transport in the environment.

Many areas along Manitoba's watercourses, particularly along the Red River valley, are prone to flooding. It is prudent to recognize this risk to facility integrity in the site selection process. Therefore, it is recommended that potential sites be located in areas where the potential risk of flooding is minimized or can be adequately controlled. Initially, it is recommended that all lands located within a 100-year flood plain be classed as unacceptable and be eliminated from consideration. The 100-year flood plain is defined as that area that would be inundated by a flood having a one percent chance of occurring in any given year.

The 100-year flood plain is generally recognized as a practical land use planning designation to accommodate flood risk. The 100-year flood plain has been mapped for selected communities in Manitoba under the Canada-Manitoba Flood Damage Agreement. These areas, along with the Red River 100-year flood plain, were designated as exclusion zones in the provincial screening process (see Chapter 4). Flood plain mapping has not been undertaken in most rural areas and a more detailed evaluation of flood risk will be required in these areas.

It is recommended that development within the 100-year flood plain be considered only under certain circumstances. Facilities can be adequately protected from the risk of flooding through engineering design. This may include the construction of berms and drainage

structures to preclude site flooding or the "flood proofing" of selected site facilities. These alternatives are considered inferior to avoiding flood plains but provide an option for consideration in the event that suitable sites are not available elsewhere.

Exclusion of the 100-year flood plain, with the option to demonstrate site protection from flood damage, is consistent with U. S. EPA regulations (Appendix A).

Development within 500 metres of a permanent surface water body is considered undesirable. This distance was selected to minimize the potential for direct impact on water quality and protect the integrity of existing riparian habitat, regardless of its current state or capability, for alternate land use. It may not be appropriate in all cases and is only recommended as an initial consideration in the selection of potential sites.

Other jurisdictions in the United States have developed or proposed set-back distances from selected surface water bodies ranging from 200 feet to one mile (Appendix A). In Canada, British Columbia has established site selection requirements which prohibit facility development within 100 to 300 metres of a surface water body, depending on facility type (Appendix B).

The Corporation recognizes that water quality issues cannot be solely addressed through facility siting. The intent of the criteria is to protect provincially designated exceptional value watersheds and provide a recommended set-back distance from surface water bodies. These are planning measures intended to identify potential sites which avoid areas where significant water quality concerns exist.

Restricting development within those portions of watersheds which provide the sole drinking water supply for communities will minimize the risk of contamination of a significant potable water supply. The intent of this criterion is not to eliminate whole watersheds from consideration but to protect against the possibility of a surface spill directly affecting water quality in community surface water supply systems. New Jersey (Appendix A) and British Columbia (Appendix B) have established similar criteria to protect community water supplies.

Water quality can be more appropriately protected through facility design and operation considerations. The facility will be designed and operated to meet the Manitoba surface water quality guidelines or additional requirements established under facility licensing procedures for all aqueous emissions.

5.3.4 Ground Water

Description: Criteria developed for the protection of ground water consider aspects of surficial geology, hydrogeology, location of sensitive groundwater supplies as well as construction and operational requirements of the facility. The overall intent of these criteria is to combine a number of considerations to aid in the identification of potential sites at the regional level which will afford adequate protection of potable water aquifers.

Criteria: The Corporation is of the opinion that adequate protection of ground water can only be confirmed through detailed site investigations. However, considerable knowledge exists regarding the location of sensitive aquifers and characteristics of the surficial geology in Manitoba to guide the selection of potentially acceptable sites. The proposed criteria are intended to provide guidance in the initial selection of candidate sites on a regional basis where, upon detailed site specific investigations, acceptable protection of groundwater aquifers may be achievable.

The following criteria are proposed to address the protection of ground water in the site selection process:

(1) Facility development will not be considered over an unconfined aquifer or in other potentially sensitive areas as defined and mapped by the Water Resources Branch as "Aquifer Pollution Hazard Areas".

(2) Surficial materials must be sufficiently thick (5 metres minimum, 10 metres recommended) and relatively impermeable (bulk hydraulic conductivity less than or equal to 10^{-7} cm/sec) as determined from existing published data.

(3) The minimum calculated time of travel along the 100 foot flow path of least resistance in the uppermost saturated zone must be in excess of 100 years.

Justification: Ground water is one of the most important pathways of potential contaminant migration from municipal, industrial and waste disposal sites. Therefore, it is essential that careful evaluation be given to this pathway in the initial site selection process. The intent of these criteria is to minimize the potential for contaminant transport via ground water and to protect the resource which consists of potable water aquifers.

Unconfined aquifers are described as those that have a defined water table and are not isolated from surface water infiltration by a significant confining layer or aquitard. Unconfined aquifers are, by definition, susceptible to contamination and protection of these areas is given priority in facility siting. The Manitoba Department of Natural Resources, Water Resources Branch, Hydrogeology Section, has defined and mapped provincial aquifers and recharge zones which are susceptible to contamination by infiltration of pollutants from the surface.

The "Aquifer Pollution Hazard Areas" include all known unconfined aquifers in southern Manitoba as well as other potentially sensitive ground water situations. These areas were excluded in the provincial screening process however, a more detailed application of this criterion at the regional level is required. Avoidance of these areas will eliminate the most sensitive hydrogeologic settings currently known in the province. Development over an unconfined aquifer or within other defined aquifer pollution hazard areas is unacceptable.

The primary objective in facility siting with respect to ground water is to provide a substantial natural barrier to the potential contamination of ground water resources. This can be best achieved by specifying some minimum parameters for the confining layer or aquitard which separates the site from underlying aquifers. Ideally, the aquitard will be as thick and as impermeable as possible. A 10 metre (32 feet) thick cover of low permeability material (aquitard) is considered desirable and a minimum depth of 5 metres is considered essential. The bulk hydraulic conductivity of this material should be 10^{-7} cm/sec or less, based on existing knowledge of the surficial materials and hydraulic conductivities observed in similar materials in the province. Although detailed site characterization will ultimately be required to verify these parameters on a site specific basis, they are considered adequate for the purpose of site selection.

It must be recognized that the proposed criteria are designed to assist in the selection of sites that may be acceptable for facility development. In order to evaluate site suitability, the site must be capable of being characterized to the extent that potential contaminant migration in the groundwater system can be modelled. Potential effects of the proposed facility on both water availability and quality of community, and individual, water supply systems will be a requirement of the detailed site investigation and environmental assessment process.

The U.S. EPA has recently developed guidelines for the identification of areas of vulnerable hydrogeology (U.S. EPA, 1986). In these guidelines, U.S. EPA has established an integrated approach to determining the ability of the location to minimize the potential for exposure from releases. This approach recommends the Time Of Travel (TOT) concept which incorporates information on geologic characteristics and the direction and rate of groundwater flow. In the TOT method, hydrogeologic vulnerability is evaluated by calculating the time it takes for ground water in the uppermost saturated zone to travel the first 100 feet (TOT_{100}) along the flow line originating at the hazardous waste management unit (U.S. EPA, 1986).

Non-vulnerable hydrogeologic settings are defined as those where the TOT_{100} is in excess of 100 years. The calculated time for groundwater to travel 100 feet along the flow pattern of least resistance in the uppermost saturated zone must be greater than 100 years. Evaluation of the TOT_{100} requires detailed site specific information and is impractical to apply at this stage of site selection. However, it can be used to determine if a site is amenable to detailed

hydrogeologic investigations and whether it is generally acceptable from the standpoint of groundwater resource protection.

As indicated, the TOT_{100} is a criterion proposed by the U.S. EPA for application in evaluating proposed hazardous waste facility sites in that country. It is assumed that this criterion is practical for application in Manitoba. Therefore, it is recommended that sites be selected based on their potential to meet the TOT_{100} criterion and it is considered desirable that potential sites meet this criterion as a minimum site requirement.

5.3.5 Wetlands

Description: Wetlands are defined as areas subject to periodic flooding from ground or surface water at a frequency to support vegetation or aquatic life dependent on saturated soil conditions. The wetland designation typically includes marshes, fens, bogs, and swamps.

Criterion: The following criterion is proposed to protect wetland habitats:

(1) Facility development will not be considered in wetland areas.

Justification: Wetlands are critical to the maintenance of existing surface and ground water regimes and often provide critical habitat for a wide range of wildlife species. These areas have traditionally been avoided by development and therefore, represent some of the best examples of natural habitat in the province. In addition, wetlands are generally unacceptable for facility development because of the potential for seasonal flooding and poor foundation characteristics.

Wetlands, depicted as organic surface deposits in the Surficial Geological Map of Manitoba, were excluded from consideration in the provincial screening process. It is important to include this criterion at the regional level to eliminate smaller, but regionally significant wetlands from consideration. As outlined in the Appendices, most jurisdictions have criteria prohibiting facility development in wetland areas.

5.3.6 Climate and Air Quality

Description Climate refers to conditions of temperature, winds, precipitation and light which define the specific characteristics of a region. Air quality refers to the composition of the atmosphere and, in particular, to the concentration of constituents of the atmosphere which have a potential to create a nuisance, or health impact on environmental receptors. Most aspects of climate and air quality (eg. rainfall, temperature, dispersion modelling etc.) will be addressed in the engineering design of facility components and the site specific

environmental assessment. However, for the purpose of facility siting, climate and air quality considerations will be limited to the proximity to populated centres and wind direction.

Criteria: The following criteria are proposed to address initial climate and air quality issues related to facility siting:

(1) Development will be restricted within 1 km of residential zoned land within any city, town or village.

(2) Consideration will be given to prevailing wind patterns in both rural and urban settings to minimize population density in the predominant downwind directions.

Justification: The Corporation recognizes that potential air quality effects on environmental receptors cannot be adequately addressed by location criteria alone. However, development within 1 kilometre of residential zoned land within a city, town or village is considered unacceptable. This proposed development restriction is intended solely to restrict development in the immediate vicinity of highly populated areas.

An airshed represents a major potential pathway for environmental contamination. The evaluation of air quality impacts associated with continuous, fugitive and accidental emissions will be a major component of the environmental assessment conducted on alternate sites. Although the science of dispersion meteorology and risk assessment is complex, the potential for extreme consequences arising from an accidental release can be minimized through site selection. In simple terms, risk will be minimized for receptors located in the least frequent wind direction with respect to the facility location. Therefore, it is desirable to locate the site in such a manner as to minimize residential population densities in the predominant downwind directions.

Several jurisdictions in the United States have established set-back distances from urban centres (Appendix A). These siting requirements are primarily intended to minimize conflict with residential land uses. Submissions received during the CEC public hearings recommended consideration of local wind patterns when siting in the vicinity of urban centres (Appendix B).

5.4 Land Use

Criteria are proposed in the following sections to address land use issues in the selection process. A description of each land use component is provided, along with presentation of proposed criteria and justification.

5.4.1 Urban Centres

Description: Urban centres are defined as any incorporated Village, Town or City, and any Local Government District - Industrial Townsite as defined in the Municipal Act, or any unincorporated centre which may meet the definition under the Act.

Criteria: The following criteria of proximity to urban centres are proposed, in order to meet the infrastructure and services requirements of an operating facility:

(1) Facility sites should be within easy commuting distance (50 kilometres recommended) of a town.

(2) Facility sites should be within reasonable commuting distance of a major urban centre (within 100 kilometres of a city is recommended).

Justification: Facility construction and operation will require outside goods and services that would ideally be available locally. Facility construction will likely create significant, but temporary, local employment opportunities and a permanent local workforce will be required for facility operation. Facility employees, and to a lesser degree construction employees, will require housing and social services within easy commuting distance. For the purpose of site selection, it is recommended that initial regional investigations be conducted within 50 kilometres of towns and 100 kilometres of cities. These proximity criteria are considered desirable to ensure that most services and amenities will be available within acceptable commuting distance.

The Corporation recognizes that these criteria will discriminate against siting in low population areas, particularly the north. The intent is not to eliminate areas from consideration based on these criteria but rather to preferentially focus on those areas that currently support local services and infrastructure that would be required by the facility and its employees. On the other hand, adherence to these criteria will ensure that facility siting will concentrate in those areas that currently generate the majority of hazardous waste.

5.4.2 Public and Private Facilities

Description: Private facilities include residences, summer homes and any other permanent structure which functions as the principal family residence on a permanent or seasonal basis. Public facilities refers to a broad range of facilities which are capable of accommodating a relatively large number of individuals on a periodic or intermittent basis. Examples include schools, hospitals, churches and community centres.

Criteria: The following criteria propose set-back distances from the property boundary of the facility site and selected private and public facilities:

(1) Facility development will not be considered within 200 metres of a residence.

(2) Facility development will not be considered within 1000 metres of a public facility.

(3) Population density and distribution will be evaluated within the region; areas exhibiting the lowest population density and the most favourable distribution will be preferred.

Justification: It is virtually impossible to establish rigid site selection criteria which adequately address public perceptions of nuisance impact and risk. These perceptions are usually over-simplified and collectively referred to as the NIMBY (Not In My Back Yard) syndrome.

Industrial development, particularly of this type, is generally viewed by the public to be incompatible with residential and selected public land uses. The intent of these criteria is to address this perception through a simplified land use planning tool, namely the establishment of minimum property line set-back requirements. These criteria are proposed as required separation distances to assist in the search for a site. They must not be interpreted as absolute distances which define a zone of impact or unacceptable risk.

The proposed minimum property set-back distance from private residences is 200 metres. A set-back distance of 1000 metres is proposed for schools, hospitals and all other public facilities. These criteria represent minimum separation distances between the facility site property line and private and public facilities. These criteria are proposed giving consideration to the numbers, and mobility of individuals which will have to be considered in the preparation of site emergency response plans. Sites which cannot meet these criteria are considered unacceptable and will not be considered.

The Corporation recognizes that the concerns of local citizens, particularly those in proximity to the facility must be adequately and equitably addressed. Although this is not an issue of site selection, future potential conflicts can be minimized through the selection of an acceptable site. Therefore, population density and distribution becomes an important consideration in the selection of potential sites. The Corporation will attempt to maximize the separation distance between the site and private and public facilities. In addition, sites exhibiting the lowest local population density, and the most favourable population distribution, will be preferred. These characteristics will help minimize potential risk to local residents and minimize the potential for future encroachment and land use conflict.

It should be noted that the finalization of these criteria will be done in consultation with affected communities. In this way, the specific preference of those directly affected can be accommodated.

The set-back distances contained in siting criteria from other jurisdictions ranges from 500 feet (150 metres) (Texas) to 1 mile (1,600 metres) (Nevada) for private residences. Set-back distances for public facilities, including hospitals, schools and churches range from 500 feet (160 metres) (Texas) to 3 miles (5000 metres) (Idaho) (Appendix A). These distances represent the minimum set-back distances from facilities and not the property lines. Minimum set-back distances from property lines range from 200 feet (60 metres) (Arkansas, Louisiana, Maine, Massachusetts, North Carolina, Oklahoma, Texas, Washington and Wisconsin) to 500 metres (Alaska) (Appendix A). As indicated, the proposed criteria are to be interpreted as minimum criteria and the Corporation will strive to maximize the separation distance between incompatible land uses.

5.4.3 Parks

Description: All current categories of provincial parks are considered, including wilderness, natural, heritage, recreational, wayside, and special use parks, as defined by The Park Lands Act. In addition, federal and municipal designated park lands are included in the definition.

Criterion: The following criteria are proposed for the protection of parks in the site selection process:

(1) Facility development will not be considered within an existing designated federal, provincial or municipal park.

(2) Facility development will not be considered within areas currently under consideration for expansion of existing park boundaries or areas under consideration for new park development.

Justification: Provincial Parks have been established for the protection and enjoyment of Manitoba's natural resources. Facility development within existing or proposed parklands is considered unacceptable and these areas are excluded. In addition, the proposed set-back distances from public facilities would also apply. These criteria are consistent with those developed in most other jurisdictions (Appendix A and B)

5.4.4 Heritage Resources

Description: Heritage resources are defined as any designated heritage site and any work or assembly of works of nature or human endeavor that is of value for its archaeological, paleontological, prehistoric, historic, cultural, natural, scientific or aesthetic features.

Criterion: The following criterion is proposed to address heritage resources in the site selection process:

(1) Facility development will not be considered on lands designated or proposed for designation under the Heritage Resources Act, at a provincial or municipal level, as a heritage resource.

Justification: Designated and proposed heritage resources represent socially significant and irreplaceable natural, historic and cultural features which are considered unacceptable for facility development. Therefore, it is proposed that these areas, and known heritage sites of significant value as determined through consultation with the Historic Resources Branch, be excluded from consideration in the site selection process. If public facilities have been established, or are proposed at any existing heritage resource sites, the set-back recommendations for public facilities would also apply.

Protection of heritage resources is consistent with criteria established in essentially all other jurisdictions (Appendixes A and B).

5.4.5 Land Claims

Description: Land claims are described as all areas registered in the Provincial Crown Lands Registry as a native land claim. These areas will become federal lands upon successful completion of the negotiation process.

Criterion: The following criterion is proposed:

(1) facility development will not be considered on any lands currently registered in the Provincial Crown Lands Registry as a native land claim.

Justification: Federal lands were excluded at the provincial level because of land use conflicts and jurisdictional issues. Lands currently registered as native land claims may come under federal jurisdiction following resolution of the claim. Therefore, development within these areas is considered undesirable and these lands would not be considered initially in the regional site selection process.

5.4.6 Renewable Resource Land Use

5.4.6.1 Agriculture

Description: The production of crops or livestock, and land capability for agricultural use are addressed under this heading.

Criteria: Criteria are proposed for the protection of significant agricultural lands based on both land capability for agriculture and agricultural land uses. The following criteria are proposed:

(1) Class 1 agricultural lands, as defined and mapped by the Canada Land Inventory (CLI) Soil Capability for Agriculture, will be excluded from consideration in facility siting.

(2) All other CLI soil capability classes will be considered although, preference will be given to Class 4 or lower agricultural lands.

(3) Consideration will be given to existing agricultural use with the view to avoid, to the extent possible, conflict with intensive agricultural production operations such as livestock, poultry, market garden, or horticultural operations.

Justification: Locating the facility in many areas of southern Manitoba would necessarily remove some lands from potential agricultural production. In these areas facility development must be considered as a competing land use and evaluated with the view to ensure the greatest benefit to the province from the use of the particular resource.

Soils rated as Class 1 under the CLI system represent the potentially most productive agricultural areas of the province. These areas are considered unacceptable for development because of their inherent value to provincial agriculture regardless of existing agricultural use. In addition, it is desirable to consider low capability agricultural land (CLI Class 4 and lower). Preference will be given to these lower capability soils in the regional identification of potential sites. Although this criterion is not exclusionary, it is intended to help minimize agricultural impacts in areas where lower capability agricultural soils exist.

Consideration will also be given to existing agricultural use. The Corporation acknowledges that avoidance of high capability agricultural land will not address all agricultural concerns related to facility siting. Therefore, it is proposed that existing agricultural land use be investigated and incorporated in the site selection process to the extent practicable. It is proposed that all intensive agricultural operations be identified. These will include intensive livestock and poultry operations (eg. dairy farms, feed lots) as well as specialty crop production operations (eg. greenhouses, market gardens). Although future agricultural land

use cannot be predicted, existing intensive uses will be avoided to the extent possible and separation from them maximized.

A few States have included criteria to prohibit the siting of hazardous waste management facilities in designated agricultural preservation areas (eg. New Jersey, Pennsylvania) and others make provision for mitigation of agricultural impacts (eg. Washington) (Appendix A). In Canada, a thorough evaluation of agricultural issues was incorporated in the siting of the proposed Ontario Waste Management Corporation facility (Appendix B). The proposed criteria address both agricultural productivity and existing use and are considered acceptable for the purpose of site selection. Detailed evaluation of alternate sites will be conducted as part of the Phase 3 investigation.

5.4.6.2 Forestry

Description: Forestry protection areas considered in the site selection process comprise seed orchards and areas identified as being of provincial significance for silviculture.

Criteria: The following criteria are proposed for the protection of significant forestry resources:

(1) Facility development will not be considered within an existing seed orchard.

(2) High capability (Class 2 and 3) forest production lands, as defined by the Canada Land Inventory, will be initially excluded from consideration in facility siting.

Justification: Forestry contributes significantly to the economy of the province and consideration of this fact is reflected in the proposed criteria. Potentially irreplaceable forestry resource areas such as seed orchards are considered unacceptable and will be avoided. Appropriate set-back distances from these areas will be determined in consultation with the Forestry Branch of Natural Resources. Areas of potentially high forestry production (Class 2 and 3 lands) are considered undesirable. Forestry Branch will be consulted in these areas to ensure appropriate steps are taken to protect and/or mitigate potential impacts on forestry, prior to consideration of these areas.

Facility development will require only a small land area (5 to 12 hectares) thereby minimizing potential impact on forestry. However, those areas considered most important in maintaining a viable forestry industry in the province (i.e. seed orchards) will be protected. Other jurisdictions have not established criteria specific to the protection of forest lands.

5.4.6.3 Fisheries

Description: For the purpose of site selection, fisheries are described as watercourses capable of supporting a sport or commercial fishery.

Criteria: The following criteria are proposed:

(1) Facility development will not be considered within watersheds defined under the Manitoba Water Quality Guidelines (ME&WSH, 1988) as "Exceptional Value".

(2) Facility development will not be considered within 500 metres of a surface water body considered important for fish production or habitat.

Justification: Fishing, both commercial and recreational, is an important part of the lifestyle and a source of income for many Manitobans. The operation of the system should not pose a threat to fish stock, populations, spawning areas or other important habitat. In all cases, development within designated exceptional value watersheds is undesirable.

The proposed criteria are considered appropriate for the protection of fisheries solely from a site selection perspective and are generally similar to those proposed for the protection of water quality. Although most jurisdictions have not promulgated criteria specifically for the protection of fisheries, most require a minimum set-back from permanent waterbodies (Appendix A and B). This, in conjunction with general guidance to avoid critical wildlife habitat areas, promotes the consideration of fisheries protection in the site selection process.

5.4.6.4 Wildlife

Description: Any impact of the facility location on wildlife is likely to be an indirect one, on wildlife habitat rather than on individual animals. Therefore, for the purpose of site selection, protection of wildlife will be achieved by protecting the land based capability for wildlife and of critical habitat essential for the maintenance of wildlife populations.

Criteria: The following criteria are proposed to accommodate wildlife concerns in the site selection process:

(1) Facility development will not be considered within lands designated as a Wildlife Management Area, or Wildlife, Furbearing Animal, Game Bird, or Goose Refuge by the province.

(2) Facility development will avoid, to the extent possible, high productivity wildlife land as defined by the Canada and Inventory as Class 1, provided that wildlife production is not currently discouraged on these lands by a competing land use.

Justification: Wildlife is of significance as an integral element of a healthy ecosystem. The facility should not adversely affect any wildlife species directly, or through a significant reduction of its habitat. While it is recognized that any removal of land from a wild state or agricultural use necessarily reduces available wildlife habitat, the land area required by the facility is relatively small. The impact will be negligible if critical pockets of habitat are avoided. Therefore, development within existing or proposed wildlife management areas or refuges is unacceptable and CLI Class 1 wildlife lands are considered undesirable. An evaluation of potential impacts on wildlife will be conducted as part of the site specific environmental impact assessment.

5.4.6.5 Ecological Reserves

Definition: Ecological Reserves are defined as areas designated under the provincial Ecological Reserves Act. These areas have been set aside to protect unique or representative habitats in Manitoba.

Criteria: The following criteria are proposed for the protection of ecologically significant areas of the province:

(1) Facility development will not be considered within existing Ecological Reserves.

(2) Facility development will not be considered within areas currently under consideration for protection under the Ecological Reserves Act.

Justification: Ecological reserves represent areas that are set aside for research, education, and nature study, to preserve plants, animals, and natural landscapes, and to serve as outdoor laboratories. Designated and proposed ecological reserves function to preserve significant environmental areas or representative ecosystems. These areas are unacceptable for facility development and are excluded from consideration. The proposed criteria are consistent with those developed in other jurisdictions.

5.4.7 Mining

Description: Mining is a resource extractive land use which is dependent on sub-surface mineral resources.

Criterion: The following criterion is proposed:

(1) Active and inactive mining areas will be excluded from consideration.

Justification: The treatment of hazardous waste is an industrial activity which, in some instances, may compete with other industrial land uses. However, if such is the case, the respective merits of the different land uses would have to be weighed against each other. Mining areas, both active and inactive, represent areas where the options for alternative surface land uses are greatly diminished. Active mining leases are considered unacceptable for facility development. Similarly, abandoned mine sites generally are not suitable for locating a hazardous waste treatment facility because, in many cases, the subsurface activities have affected structural integrity of the site, and/or created abnormal patterns of ground water movement. Such sites would make monitoring extremely difficult, and potentially compromise the safety of buildings and facilities.

5.4.8 Proposed Development Areas

Definition: A proposed development area is defined as any area reserved, allocated, or under formal consideration for future development, or use. Proposed development areas include Designated Reservoir Areas under the Water Resources Act, Designated Power Reserves under the Water Power Act and may include specific land use classifications in municipal plans.

Criteria: The following criteria are proposed to minimize potential conflict with future land uses:

(1) Facility development will not be considered within a designated reservoir area or power reserve unless it can be demonstrated that no potential conflict exists between the proposed uses.

(2) Facility development will not initially be considered within lands designated as development reserves or other areas considered incompatible with facility development.

(3) Facility development will not initially be considered on lands for which active development proposals are currently being reviewed by local or provincial planning and/or regulatory authorities.

Justification: Areas of the province are reserved under existing legislation for specific land uses. Examples of these include designated reservoirs and power reserves. Development within these areas is restricted so as not to conflict with existing and/or potential future intended use.

The overall intent of these criteria is to minimize potential conflict with development which is clearly in the public interest. Therefore, development must consider regional and municipal land use plans to ensure compatibility with existing or proposed adjacent land uses. For this reason, development restrictions or other potentially incompatible land use zoning classifications established under any land use planning authority are considered undesirable. These areas will be identified through consultation with provincial, regional and municipal planning authorities and investigated to determine their compatibility with the proposed facility. In addition, active development proposals will be reviewed and areas eliminated from consideration as deemed necessary.

5.5 Summary

The proposed regional site selection criteria naturally fit into four categories as defined below:

- Essential criteria define required site characteristics; areas which do not meet these criteria will be eliminated from further consideration.

- Desirable criteria define site characteristics which are preferred, but not essential; areas exhibiting desirable characteristics will be given preference over those which do not.

- Unacceptable criteria identify site characteristics which are considered incompatible with facility development; areas exhibiting unacceptable characteristics will be excluded from consideration in the site selection process.

- Undesirable criteria define site characteristics which are undesirable but not unacceptable; areas with these characteristics will be given a lower priority in the site selection process.

Two of the categories address required (essential) characteristics of an area on one hand, and exclusionary (unacceptable) characteristics on the other hand. Absence of the one, or presence of the other will rule out a site entirely.

Similarly, the other two categories address site characteristics that are either desirable or undesirable, for various reasons. The facility could be built in areas lacking desirable, or possessing the undesirable characteristics, at a cost of either higher capital outlay, or potentially greater environmental impact. Therefore, sites exhibiting desirable characteristics or those avoiding undesirable characteristics, will be given preference in the selection of potential sites.

The justification for proposed criteria can be categorized under the following headings:

- o technical and engineering design;
- o environmental protection;
- o social/public health; and
- o land-use.

Table 5.1 presents a summary of all criteria proposed for consideration in the identification of potential sites within candidate host communities. Criteria are summarized as "essential", "unacceptable", "desirable" or "undesirable" as defined above and the primary considerations for justification of each criterion is also presented.

TABLE 5-1
PROPOSED CENTRAL FACILITY SITING CRITERIA

CRITERIA	JUSTIFICATION			
	TECHNICAL	ENVIRONMENTAL	SOCIAL	LAND USE
Unacceptable Characteristics				
limestone bedrock (karst terrain)	•	•		
seismic risk areas	•	•		
unstable terrain	•	•		
100-year flood plain	•	•		
water supply reservoir watersheds		•		
groundwater pollution hazard areas		•		
WMA's and game refuges		•		•
ecological reserves		•		•
wetlands	•	•		
parks		•	•	•
heritage sites			•	•
class 1 agricultural capability		•		•
seed orchards		•		•
mines (active or inactive)	•			•
reservoir and power reserves				•
within 1 km of a City, Town or Village			•	•
within 200 m of a private residence			•	•
within 1000 m of a public facility			•	•

CRITERIA	JUSTIFICATION			
	TECHNICAL	ENVIRONMENTAL	SOCIAL	LAND USE
Undesirable Characteristics				
steep hills (greater than 15% slope)	•	•		
within 500 m of a water body		•		
designated exceptional value watersheds		•		
intensive agricultural use				•
Class 2 and 3 agricultural capability		•		•
Class 2 and 3 forestry capability		•		•
Class 1 wildlife capability		•		•
development reserves				•
areas considered for other development				•
land claims				•

TABLE 5-1 (Continued)

CRITERIA	JUSTIFICATION			
	TECHNICAL	ENVIRONMENTAL	SOCIAL	LAND USE
Essential Characteristics				
within 25 km of a PT Highway	*			
access to essential services	*			
65 ha (160 acres) of land	*			*
till/clay, greater than 5m thick	*	*		

CRITERIA	JUSTIFICATION			
	TECHNICAL	ENVIRONMENTAL	SOCIAL	LAND USE
Desirable Characteristics				
rail access	*			
clay/till greater than 10 m thick	*	*		
TOT_{100} greater than 100 years		*		
crown land			*	*
minimum population density			*	*
within 50 km of a town			*	
within 100 km of a city			*	

6.0 SITE SELECTION CRITERIA - TRANSFER STATIONS

6.1 Introduction

Regional transfer stations will be required by the hazardous waste management system to provide an equitable and cost effective service to all provincial generators. They will function as the "door" to the system, and as such must be conveniently located. Transfer stations are not hazardous waste treatment or disposal facilities and the proposed criteria reflect this fact.

For practical reasons, transfer stations will be sited within or immediately adjacent to existing urban centres. Geographical locations will be determined based on the provincial and regional distribution of waste generation, the central facility site and an evaluation of need and accessibility. The intent of these criteria is to identify acceptable site(s) within these locations. Therefore, not all of the criteria developed for siting the central facility will be applicable to transfer stations.

6.2 Site Selection Criteria

The following sections summarize the proposed technical, environmental and land use criteria for siting transfer stations. In developing criteria for the siting of the central facility, emphasis was placed on finding sites which exhibit significant natural barriers to environmental contamination. The primary objective was to minimize the dependence on engineered solutions. Transfer stations will be sited with utility in mind. Although it may not be necessary to achieve the same level of secondary containment considered appropriate for the central facility site, adequate protection must be provided. Consequently, the proposed criteria allow greater flexibility for the application of engineered solutions in this situation.

6.2.1 Technical Criteria

Technical criteria address the technical aspects and/or requirements of transfer stations which are important to consider in the site selection process. In order to develop technically oriented criteria, it was assumed that all regional transfer stations share a common design and capacity. However, the design of each will include site specific considerations.

Technical criteria associated with transfer stations include access, services and land requirement. Each is discussed in detail in the following sections.

6.2.1.1 Access

Criteria: The following criteria are proposed:

(1) Candidate sites must be located on, or immediately adjacent to an existing truck route, or be within a distance considered economically feasible to service by road.

(2) Candidate sites should be located on an existing rail trunk or spur line or be within a distance considered economically viable to service by rail.

Justification: By definition, transfer stations must be accessible by road to accept and ship wastes. Existing road access alternatives must be classed as provincial truck routes or be capable of upgrading for classification as a designated truck route.

Rail access is preferred. Depending on the waste generation in individual regions, it may be feasible to bulk considerable quantities of wastes for transport to the central facility, or to out-of-province treatment facilities. Economic access to a rail line would provide the greatest flexibility in arranging for bulk waste shipments.

6.2.1.2 Services

Service requirements for transfer stations will be minimal in comparison to the treatment centre. Since no significant treatment will be conducted, with the possible exception of some waste reduction technology, no special requirements are anticipated. However, access to essential services (eg. electric power, natural gas, water, sewer and telephone) at a level consistent with that normally provided for existing industrial parks will be required.

6.2.1.3 Land Requirement

Transfer stations will require a minimum amount of land. A minimum of 1.6 ha (4 acres) is recommended for "stand alone" facilities. This lot size should be readily available in existing industrial parks and will provide adequate space to accommodate all site buildings and infrastructure. Additional land may be warranted at "greenfield" sites where additional service connections may be necessary. In this case, a minimum lot size of 4 ha (10 acres) is recommended.

6.2.2 Physical and Environmental Criteria

Physical and environmental considerations for siting are presented in the following section. Since transfer stations will be located within or adjacent to existing urban centres the

potential for significant conflict with environmental resources, particularly designated environmental land uses such as ecological reserves, will be minimized. The proposed criteria address those issues considered critical to the preservation of environmental quality in the vicinity of transfer stations.

Criteria: The following criteria include those environmental factors which are considered important to include in the selection of potential sites:

(1) Transfer stations will not be allowed in areas of unstable terrain including karst terrain, seismic prone areas or areas prone to mass erosion unless it can be demonstrated that facilities can be designed, constructed, operated and maintained so as to minimize any risk to facility integrity.

(2) Transfer stations should not be located over unconfined aquifers.

(3) Transfer Stations will not be allowed within a 100-year flood plain unless it can be demonstrated that the facility can be designed, constructed, operated and maintained to protect against the release of contaminants in the event of a flood.

(4) Transfer stations will not be considered within 200 metres of a water course or water body used as a public drinking water supply or for recreation.

(5) Potential sites should be underlain by a minimum of 5 metres of clay or till material with a bulk hydraulic conductivity of 10^{-7} cm/sec or less. If this is not available locally, a detailed hydrogeological evaluation will be necessary to determine the requirements for monitoring and development of acceptable engineered controls.

(6) Transfer stations will be located to minimize urban and rural population density in the predominant downwind directions.

Justification: These criteria are generally similar to those proposed for the central facility (Refer to Chapter 5 for a more complete discussion of these items). The proposed criteria however, are fewer in number and provide more latitude for the application of engineering controls.

It was assumed that there would be virtually no conflict between transfer stations and designated natural areas. This however, would be confirmed prior to applying the proposed criteria. The main intent of the proposed criteria is to limit the potential for the transmission of contaminants from the site. The criteria therefore address the major pathways of contaminant transport (ground water, surface water and air).

Criteria proposed to protect surface water quality include exclusion from 100-year flood plains and a 200 metre set-back from water courses. Both of these are designed to minimize the potential for uncontrolled releases to reach sensitive water bodies prior to the implementation of remedial action. The flood plain criterion is also designed to protect the facility from flood damage.

The protection of potable water aquifers is an important consideration in the siting of transfer stations. Therefore, development over unconfined aquifers is considered undesirable and sites with similar surficial geological conditions as the central facility site are preferred. In areas where this cannot be achieved, provision is made for a detailed hydrogeological investigation to determine the most appropriate methods for protection of potable water aquifers and the development of a groundwater monitoring system.

Consistent with the criteria proposed for the central facility, local wind patterns will be investigated in an attempt to minimize residential population densities in predominant downwind directions.

6.2.3 Land Use Criteria

Land use criteria are extremely important to consider in this case because of the proximity to urban centres. The following section outlines proposed land use criteria, particularly those related to zoning and set-back distances, which are considered appropriate for siting transfer stations.

Criteria: The following land use criteria are specific to the siting of transfer stations and address potential land use conflicts within a predominantly urban setting:

(1) Transfer stations must be sited in existing industrial zoned areas or areas proposed or considered for future industrial development.

(2) Transfer stations must be considered a designated or discretionary land use under the existing zoning By-law for industrial land in the Municipality under consideration.

(3) Recommended separation distances from the property boundaries are:

- Residential zoned land 200 metres
- Public facilities 500 metres

(4) Provision should exist within the local land use By-laws to exclude incompatible land uses from the buffer zones defined above.

Justification: These criteria are recommended to ensure that transfer stations are located in appropriately zoned industrial areas where potential nuisance and/or land use compatibility concerns on adjacent lands will be minimized. In addition, buffer zones are proposed to maintain minimum distances from private and public use facilities. The recommended set-back distances are less than those recommended for the central facility site. These criteria address the reality of having to locate in a more heavily populated area and reflect the Corporation's desire to minimize local concerns related to facility operation. The smaller buffer zones are justified, in this case, because all wastes will be properly packaged, individual waste residence time on the site will be short, and there will be no on-site treatment.

The Corporation will be careful in attempting to minimize potential land use impacts. The proposed criteria are minimum requirements and in application, sites exhibiting greater separation characteristics will be preferred. The Corporation also recognizes the need to ensure that future, potentially incompatible land uses are not allowed to encroach on the facility. For this reason, some form of control over future land use within the proposed buffer zones is recommended.

6.3 Summary

Transfer stations will be required in several areas of the province to provide convenient access for all generators. Received wastes will be identified, properly packaged, and stored until shipment to treatment facilities.

Technical, environmental and land use criteria described in this section are summarized in Table 6-1. Criteria describe "unacceptable", "undesirable", "essential", or "desirable" characteristics of potential sites consistent with the classification used for the central facility siting criteria. Transfer station development will not be considered within areas exhibiting unacceptable characteristics. Also, potential sites must exhibit essential characteristics and will preferably also exhibit desirable characteristics.

TABLE 6-1
SUMMARY
PROPOSED TRANSFER STATION SITING CRITERIA

CRITERIA	JUSTIFICATION			
	TECHNICAL	ENVIRONMENTAL	SOCIAL	LAND USE
Unacceptable Characteristics				
Unstable terrain	*	*		
100-year flood plain	*	*		
within 500 m of public facilities			*	*
within 200 m of residential zoned land			*	*
within 200 m of a water course		*		
Undesirable Characteristics				
Unconfined aquifers		*		
Essential Characteristics				
1.6 ha of land	*			
Accessible by highway	*			
Availability of services	*			
Industrial zoning				*
Compatible with land use bylaws				*
Desirable Characteristics				
Railway access	*			
Clay/till soils		*		
Minimum population density			*	*

7.0 REGIONS OF INTEREST

The intent of this section is to provide further definition of regions where the potential to site a fully integrated hazardous waste management facility in Manitoba is the highest. Potential sites must be capable of meeting the detailed regional criteria as proposed in Section 5. The provincial screening work narrowed the scope considerably by removing from initial consideration those areas considered unacceptable for obvious technical, environmental, and land use reasons. Following the development of proposed regional site selection criteria and preliminary ranking of criteria as to overall importance, it is possible to further narrow down regions of greatest interest.

The provincial screening was conducted as a first step in the identification of potential sites. Since no site requirements were included in the screening, the composite constraint map (Figure 4-10) only depicts those areas where facility development is considered unacceptable. The assumption was made that all constraint free areas warrant further investigation as potentially acceptable areas. However, following development of the more detailed regional site selection criteria, it is obvious that not all "constraint free" areas will meet the site requirements. An examination of the proposed central facility siting criteria is now warranted to provide more direction to the selection of "acceptable areas".

Of the "essential" criteria proposed in Chapter 5, only those related to surficial geology are suitable for site screening on a provincial basis. The most important criteria in defining suitable areas are those related to the thickness and type of surficial materials. This information can be mapped for non-excluded areas to identify those regions to be concentrated on first.

The following criteria are proposed as "inclusion" criteria in this work:

- the region must be underlain by clay, glacial till or a combination of the two; and

- clay and till deposits should be 10 metres or greater in thickness.

It is noted that 5 metres of clay or till is the minimum site requirement (Section 5.3.4). However, consistent data are not available for all map sheets included in this study and therefore, the 10 metre thickness is presented. This depth of surficial material is recommended as the "desirable" depth and is considered appropriate for defining the regions of greatest interest.

When applied in combination with the provincial screening results, these criteria identify regions with significant potential to meet all siting requirements.

Figure 7-1 was generated from detailed surficial geology maps available for southern Manitoba. Data were obtained from the Groundwater Availability Map Series prepared by Manitoba Natural Resources, Water Resources Branch. This map series includes a variety of parameters, the most pertinent to this exercise being surficial geology and drift thickness. The location of clay and till surficial deposits with depths exceeding 10 metres (32 feet) are presented in Figure 7-1. Figure 7-2 combines this information with the provincial screening results. Figure 7-2 shows only those areas which are free of provincial constraints and have the recommended surficial deposits. These areas will have the greatest potential, on a provincial basis, to meet the siting requirements of the central facility.

Clay deposits are preferred over glacial till because of generally lower permeability and greater uniformity. The greatest concentration of clay deposits in southern Manitoba occur in the Winnipeg region (Figure 7-1). The thickness of clay in the glacial Lake Agassiz basin surrounding Winnipeg range from several metres to in excess of 100 metres in selected locations. Also, potable water aquifers are absent in much of this area, particularly south of Winnipeg, making the region ideal for consideration in the site selection process. Figure 7-2 identifies those portions of the Winnipeg region clay deposits which are considered suitable for further consideration. The major constraint to siting in this region is the Red River 100-year flood plain.

Other areas with suitable clay deposits are located in the north-eastern Interlake, Dauphin Lake, Swan River and in isolated areas near Brandon (Figure 7-2).

Glacial till deposits are located throughout southern Manitoba. The largest continuous till deposits are located south of Riding Mountain National Park and in the Boissevain areas south of Brandon. Much of the till areas are free of provincial screening constraints (Figure 7-2) and are considered suitable for further consideration.

The greatest limitation to this approach is that consistent detailed information are not available for the entire province. Therefore, regions of the northern interlake and northern Manitoba cannot be evaluated on an equal basis. This is, in essence, a constraint to facility siting in these areas since the time and cost of generating this information would be prohibitive. However, if specific community interest was expressed from within these areas, the necessary data collection could be undertaken.

As indicated at the outset, the site must be acceptable from technical, environmental, land use and social perspectives. Based on the results of this work, the greatest potential to meet the technical and environmental site requirements are in those regions identified in Figure 7-2. While these regions will receive specific attention in terms of soliciting community interest, other areas can be considered if community interest is expressed and constraint free areas, not identified at the provincial level, can be located.

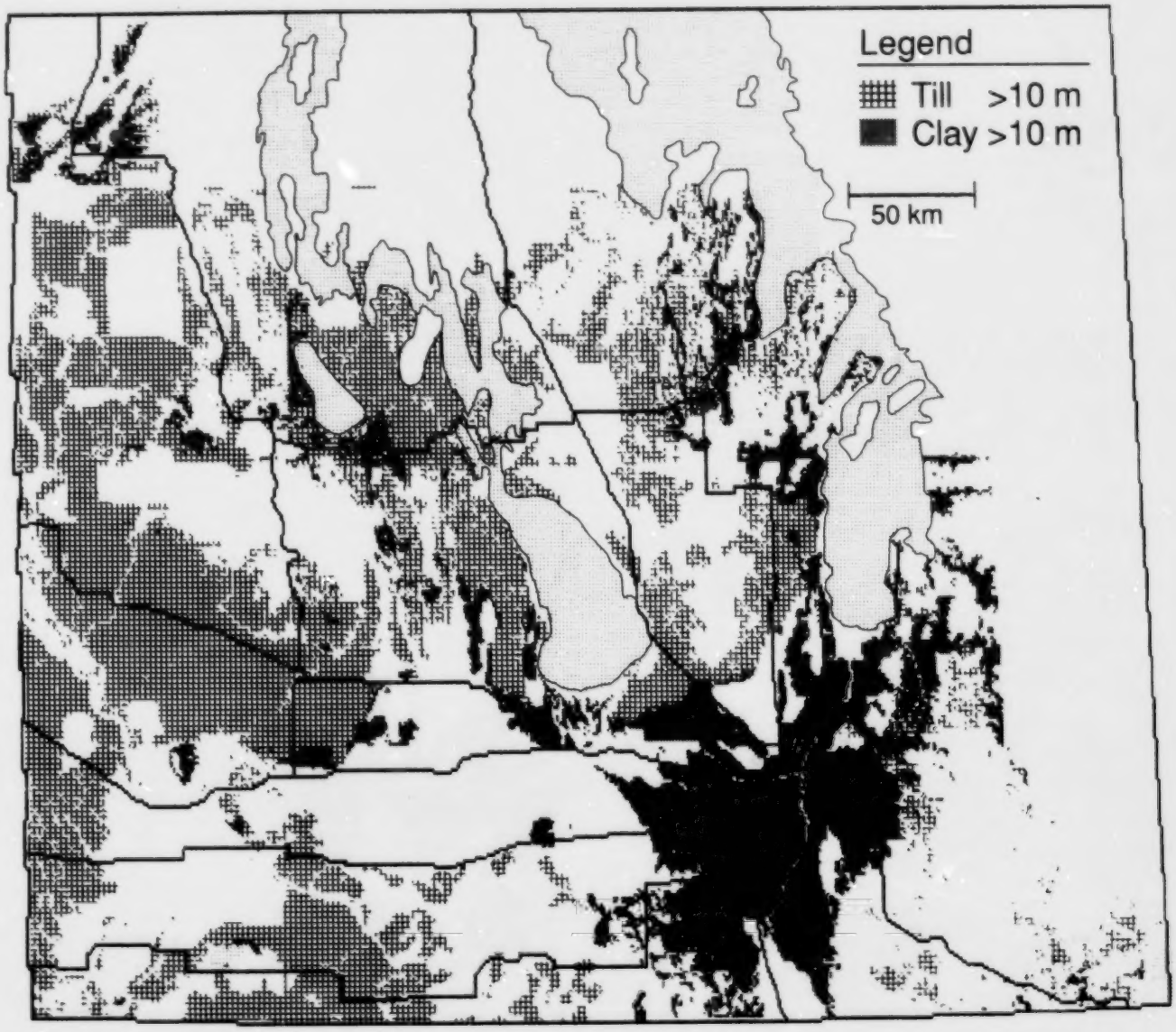

Figure 7.1. Clay and Till Deposits in Southern Manitoba

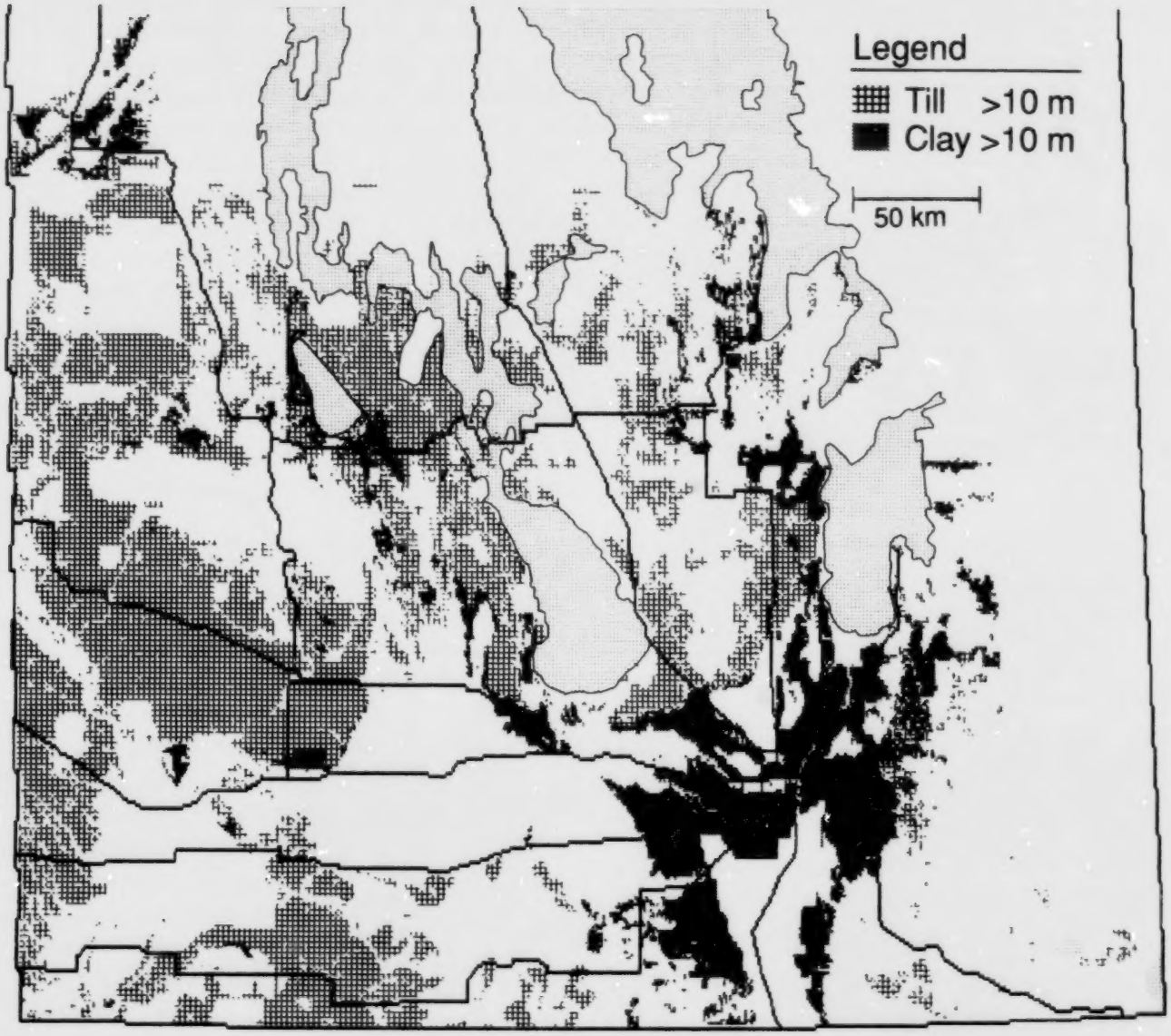

Figure7.2. Regions of Greatest Interest

As indicated in the site selection objectives, the Corporation will actively seek local support for its siting initiatives. The Corporation will only proceed with detailed site selection in those areas which have invited us to do so, or in areas where ongoing public support has been demonstrated. Also, participation in the process is voluntary and communities are free to withdraw at any time.

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APPENDIX A

SITE SELECTION CRITERIA AND APPROACHES IN THE UNITED STATES

The following sections outline siting criteria and site selection processes (where applicable) in the United States. Criteria recommended by the U.S. EPA are outlined. In addition, State authorities were surveyed to obtain information on site selection criteria required for siting hazardous waste facilities in their jurisdictions. A summary of State responses are included. In addition, a summary of State site selection criteria was prepared under contract for the U.S. EPA in 1987. Results of this study are also included for reference.

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A 1.0 U.S. EPA Siting Guidance Manual

The U.S. EPA has prepared a guidance manual for the siting of hazardous waste land storage and disposal facilities (U.S. EPA, 1985). The document was prepared in 1985 and presents criteria defining acceptable physical locations and applicable U.S. regulations. The U.S. EPA is currently developing a new set of criteria which will be promulgated in regulations as the minimum location standards for land storage and disposal facilities. These criteria are currently being reviewed and are expected to be enacted by the fall of 1989 (pers. comm. Mr. G.R. Galen).

At present the U.S.EPA, through its guidance manual, has established siting guidance and/or criteria in five general areas as outlined below:

- Site Characterization;
- High Hazard and Unsuitable Terrain;
- Ability to Monitor at Location;
- Protected Lands; and
- Vulnerable Hydrogeology.

Criteria in each of these areas is summarized in the following sections.

A 1.1 Site Characterization

Site characterization refers to the inherent geologic, hydrologic and pedologic features of the site. It is recommended that a detailed site characterization be conducted. This information would be used to determine compliance with siting criteria and to provide information suitable to predict groundwater movement and transport of constituents should the engineered containment unit fail.

A 1.2 Geologically Complex Locations

Certain geologically complex areas will require more extensive investigation to meet the characterization performance requirements. However, from a practical perspective not all sites can be adequately characterized due to complex hydrogeologic conditions. In addition, geologically complex areas may be unsuitable for development due to unstable or high risk of failure characteristics. These areas, as outlined below, should be avoided in the site selection process:

- o geologically complex areas including karst terrain or fractured bedrock;
- o high hazard and unstable terrain including areas exhibiting landslide, subsidence, vulcanism or seismic events; and
- o flood prone areas are restricted from development under existing location standards. These areas include the 100-year flood plain, channel encroachment and wetland areas.

The U.S. EPA has established a number of factors to consider in evaluating these siting considerations. These are outlined in detail in the Guidance Document (U.S. EPA, 1985).

A 1.3 Ability to Monitor the Location

The site must be amenable to monitoring under existing monitoring requirements for hazardous waste treatment and disposal facilities. The primary consideration is for defining and establishing a hydrogeologic monitoring system. Some situations that may require special attention include:

- o areas that are located above water-table mounds;
- o areas above aquifers where ground water flow directions change seasonally or due to tides; and
- o locations in proximity to other waste management or potentially polluting industries.

Again, the U.S. EPA has established guidance for setting up a groundwater monitoring program. This information is available in "Criteria for Identifying Areas of Vulnerable Hydrogeology Under RCRA" (U.S. EPA, 1986)

A 1.4 Protected Lands Criteria

Protected lands include the following:

- o archaeological and historic places;
- o endangered and threatened species habitat;
- o national parklands;
- o wetlands;
- o wilderness areas;
- o wildlife refuges;
- o coastal areas; and
- o significant agricultural areas.

Facilities are generally restricted, under existing federal and state legislation, from development in designated protected lands.

A 1.5 Vulnerable Hydrology

The U.S.EPA developed "guidance criteria" to identify areas of vulnerable hydrogeology (U.S. EPA, 1986). As these criteria are applied, regulations may be developed to restrict development of hazardous waste storage and treatment facilities in vulnerable settings above Class I and II ground water. Class I ground water is an "irreplaceable source of drinking water" or an "ecologically vital" source of water. Class II ground water is defined as currently used or potentially available sources of water. Class III ground water is defined as saline or contaminated ground water which is unsuitable for consumption and is hydrogeologically isolated.

As indicated, the U.S. EPA is in the process of setting minimum siting criteria. These criteria are currently being reviewed and are expected to be promulgated by the fall of 1989.

A 2.0 State of California

Assembly Bill 2948 (AB 2948) provides the legal basis for the preparation of county or regional hazardous waste plans in the State of California. Subsequent to this requirement, guidelines aimed at assisting counties or regions in preparing hazardous waste plans have been published. Included in hazardous waste plans are provisions requiring siting criteria in the document. Hazardous waste plans are reviewed by the California Department of Health to prevent siting criteria from unreasonably impairing the feasibility of siting new facilities. In addition, the guidelines list specific siting criteria to be used, as a minimum, in siting new facilities.

A 2.1 High Hazard Areas

- Facilities are restricted from siting within 200 ft. of an active or recently active fault.
- Above ground facilities may be built in areas within a 100-year floodplain (includes areas subject to flooding by a dam or levee failure) if protected by appropriate engineering solutions. Landfills may not be located in such areas even with the appropriate engineering solutions.
- No facilities can be sited in wetlands.
- Facilities cannot be located within critical habitat areas.
- Facilities located within areas of unstable soils should have engineered design features to assure structural stability.
- Facilities should not be sited within major recharge areas for aquifers, especially those facilities with landfills.

A 2.2 Public Safety

- Buffer zone of 2000 ft. is required for facilities with engineered landfills.
- A risk assessment to determine the need for buffer zones between the facility and immobile populations (schools, hospitals, prisons, etc.) must be carried out.
- Facilities should be sited to minimize the transportation distance from waste generation sites to the facilities, avoiding residential areas.

A 2.3 Physical Limitations of the Site Area

- Landfills must conform to requirements of the State Water Resources Control Board and all other types of facilities must have engineered structural features to contain spills and provide the capacity for monitoring.

- Facilities cannot be sited on prime agricultural lands unless overriding public needs for facilities in such a location are demonstrated.

- Depth to groundwater for landfills must meet with State Water Resources Control Board standards and above ground facilities must have engineered design features if located within high groundwater areas.

Facilities are restricted from being sited in areas where air emissions may significantly deteriorate ambient air quality.

A 2.4 Location-Specific Criteria

- Assessment of risk associated with operation of facilities in proximity to areas of high population should be determined.

- Risks associated with transportation of wastes to facilities should be minimized by siting them in proximity to waste generation sources.

- Facilities should generally be sited in land zoned as industrial and commercial, but should not be restricted to these areas.

- Facilities should not be allowed in recreational, cultural or aesthetic areas.

- Facilities should not be sited so as to preclude extraction of minerals necessary to sustain the economy of the State.

- Military land shall not be considered for the establishment of public hazardous waste management facilities.

- The above criteria are considered suitable for siting facilities within other State, Federal and Indian lands.

A 3.0 State of Connecticut

The State of Connecticut has enacted legislation dealing with hazardous waste management (Hazardous Waste Act, Chapter 445), with provisions for the development of regulations concerning siting of facilities. Hazardous Waste Siting Regulations, proclaimed in March 1985, set forth the requirements, standards and application procedures required by the State siting council for the siting of hazardous waste facilities.

The regulations outline the necessary factors that must be considered in the application phase facility development. Included are impacts of the proposed facility on the immediate geographic area in terms of public health, safety and welfare. In addition, the regulations contain minimum distance requirements for proposed facilities in the State.

A 3.1 Minimum Distance Requirements

- Land based facilities (landfills, surface impoundments, land treatment facilities, injection wells and waste piles) must be at least 400 ft. from all other land uses.

- Non-land based facilities (incinerators, thermal, phys/chem/biological treatment, recovery, and storage facilities)must be at least 150 ft. from all other land uses.

- Distances less than the minimum requirements may be deemed adequate in consideration of the following factors:

    - whether the different distance provides an adequate margin of safety in terms of public protection, detection of hazardous wastes, and remedial measures;
    - site specific hydrogeological conditions;
    - localized climatic conditions;
    - population density in the vicinity of the proposed facility;
    - the degree of hazard of the wastes proposed to be handled at the facility; and
    - specific design features incorporated in the facility to reduce potential hazard to the public.

A 4.0 State of Georgia

The state of Georgia adopted federal RCRA siting standards. Additional material distributed by Georgia Department of Natural resources includes the following environmental, technical and social objectives and criteria, developed under contract by a consulting firm:

A 4.1 Environmental

- o low permeability soil;
- o ground water deep below surface;
- o widely dispersive atmospheric characteristics;
- o no impact on endangered species habitat;
- o distant from sensitive plants and animals;
- o protection from 100-year flood; and
- o out of active seismic zones.

A 4.2 Technical

- o capable of monitoring, characterization, and modelling;
- o outside active seismic areas;
- o outside erosion, slumping, or landslide areas;
- o on stable geologic substrate; and
- o ensure process, drinking, and sanitation water supply.

A 4.3 Social

- o minimize costs:direct financial, external social costs, transport/delivery costs, disposal/discharge costs to both users and operator;
- o avoid areas where projected population growth would conflict with the objectives of the facility;
- o avoid sites of historical/cultural resources;
- o avoid special use areas, such as parks or high value agricultural uses; and
- o prefer sites distant from population centers.

A 5.0 State of Idaho

Pursuant to the State Hazardous Waste Facility Siting Act (Idaho Code Section 39-5801), Idaho has developed a hazardous waste management plan. The plan was adopted by the Idaho State Legislature in March of 1987. Included in the plan are minimum technical siting criteria for commercial hazardous waste land disposal facilities within Idaho. These criteria apply only to future commercial hazardous waste facilities, not existing or future private industrial facilities.

A 5.1 Minimal Technical Siting Criteria

No new hazardous waste facilities can be sited where:

- depth to seasonal-high groundwater is less than 100 ft. below the lowest point of disposal;
- thickness of fine-grained unconsolidated sediments above the water table is less than 25 ft.; or
- depth to fractured rock is less than 100 ft. below the lowest point of disposal.

With respect to hydrogeologic features, no new hazardous waste facilities can be sited within:

- 2500 ft. of surface water bodies;
- 1000 ft. of existing public/private and irrigation water supplies;
- a floodplain of a 500-year flood
- areas that are in close proximity of active fault zones or other tectonically active or unstable areas; or
- areas overlying any subsurface mining.

With respect to the population in the general vicinity of proposed facilities, no new facilities can be sited within:

- 5000 ft. of any off-site residential structure that is routinely occupied at least 8 hours/day;
- 3 miles of schools, airports, hospitals, churches; or
- 3 miles from a population centre greater than 150 people.

Proposed hazardous waste facilities must have an "inactive" buffer zone of at least 500 ft. around the "active" portion of the facility.

A 6.0 State of Maine

The State of Maine Department of Environmental Protection publishes Hazardous Waste Management Rules adopted under the Maine Hazardous Waste, Septage & Solid Waste Management Act.

A 6.1 Exclusionary criteria

It is prohibited to locate a waste facility

- on wetlands;
- within a 100-year flood plain (new facilities);
- over sand or gravel aquifer or high-yield bedrock aquifer; and
- within park or wilderness areas (except storage facilities).

In addition, a number of performance standards regulate design of individual components, monitoring, and allowable emission limits.

A 7.0 State of Michigan

The State of Michigan's hazardous waste legislation provides the means for preparing state-wide hazardous waste management plans. This includes proposing criteria for determining acceptable locations for hazardous waste facilities. The Hazardous Waste Division of the Michigan Department of Natural Resources has laid out rules which apply to generators of hazardous wastes, including minimum location standards for siting of facilities.

A 7.1 Location Standards

- o No facilities shall be sited within:
  - 61 metres of a fault;
  - in a floodway;
  - in a coastal high-risk area;
  - over a sole-source aquifer or a recharge zone fo ra sole-source aquifer;or
  - in a wetland.

- o Isolation distances from facilities to other property line is 150 metres for landfills and 60 metres for other facilities.

- o Facilities shall not be located in a floodplain unless:
  - the facility is designed and operated to prevent washout of hazardous waste by a flood; or
  - waste can be removed prior to flood waters reaching the facility.

- o Landfills, surface impoundments and waste piles can only be located where there is at least 6 metres of soil with a maximum permeability of 1.0×10^{-6} cm/sec at all points lateral to the liner or bottom of facilities.

A 8.0 State of Minnesota

The State of Minnesota has recently initiated a siting process to identify candidate site(s) for a hazardous waste management facility. The siting approach adopted by the State (Waste Management Board) was different than that used in other jurisdictions. The Waste Management Board approached Counties to identify those with an interest in hosting a facility. Interested Counties were offered a financial benefits package to assist them in informing and educating citizens about the facility and the siting process. Each County participating in the program will then work closely with the WMB to find a location that offers maximum protection for the environment and public health (Minnesota Waste Management Board, 1987).

A 8.1 Mandatory Restrictions

The following criteria are mandatory under State statutes or Rules (Minnesota Waste Management Board, 1987). These criteria were presented to Counties as locational guidelines to assist them in identifying areas that may be suitable to undergo more detailed assessment.

- the facility cannot be located in any place that can reasonably be expected to cause pollution of potable water;

- the facility cannot be located where the topography, geology, hydrology or soil is unsuitable for the protection of groundwater. These areas include:

  - highly permeable surface materials;
  - shallow, unconfined or bedrock aquifers;
  - shallow Quaternary aquifers;
  - groundwater recharge areas;
  - seasonal high water tables;
  - steep and unstable slopes;
  - mappable peat deposits; and
  - surface and shallow underground mines.

- the facility should not be located in area... ...terized by karst features;
- the facility may not be located in wetlands, shoreland or a 100-year floodplain;
- the facility must not be located such that ambient air quality standards may be exceeded; and
- protected lands including historic sites, protected habitat, parks etc. should be avoided.

A 8.2 Additional Guidelines

The following locational guidelines are recommended for consideration in facility siting:

- the facility is an industrial development and should be located in an appropriate area, giving consideration to existing and proposed land use;
- the site should have reasonable access to major 2-lane or 4-lane, 9-ton highway, and;
- the facility should not be located in areas of known or threatened groundwater contamination.

These criteria are proposed to be used as general screening criteria to identify candidate areas only. A more detailed assessment of proposed areas would then be undertaken.

A 9.0 State of Nevada

The State of Nevada has enacted Hazardous Waste Management Regulations encompassing disposal of hazardous wastes and facilities for the management of hazardous wastes. Included in the regulations are exclusionary criteria for the location of stationary facilities for treatment, incineration or disposal of hazardous wastes.

A 9.1 Exclusionary Criteria

Facilities must not be constructed within 1 mile of:

- a permanent dwelling;
- an area zoned solely for residential use;
- a public park;
- a wildlife management area;
- key wildlife habitat or habitat for threatened or endangered species;
- areas of surface water or wetlands;
- natural or man-made geologic hazards; or
- an existing well which supplies public drinking water.

o Facilities must not be constructed in areas designated as historical or archaeological sites.

o Facilities must not be constructed within a 100 year floodplain.

o Facilities must not be constructed in an area where the water table seasonally rises to within 150 feet of the surface.

A 10.0 State of New Hampshire

Hazardous Waste Rules (Chapter/part He-P 1905) are published by the State of New Hampshire Department of Environmental Services.Regarding siting of facilities, there are no specific exclusionary criteria stated, however, with permit submissions for hazardous waste disposal facilities the following must be addressed:

- o Seismic information, especially location of Holocene faults;
- o Measures to prevent hazards in loading, prevent runoff from handling to other areas of the facility, to prevent contamination of water supplies, to prevent undue exposure of personnel;
- o 100-yr floodplain delineation (500-yr for those who receive off-site waste (identification only) and statements of measures adopted to withstand washout from 100-year-flood water levels);
- o Detailed relief maps;
- o Surface waters;
- o Groundwater table configuration, location of aquifers;
- o Ground water monitoring;
- o Wind direction rose;
- o Access control;
- o Drainage and flood control structures and barriers;
- o Process description;
- o Transport routes and traffic pattern evaluation;
- o Leachate control for surface impoundments;
- o Control of wind dispersal from stockpiled material; and
- o Monitoring and pollution control systems.

A 11.0 State of New Jersey

The State of New Jersey has a legislated "Hazardous Waste Facilities Siting Act" (N.J.S.A. 52:14B-1 et seq) which establishes the criteria for the siting of major commercial hazardous waste facilities. The primary objective of the act is to set minimum location standards which will prevent any significant threat to human health or the environment (New Jersey Hazardous Waste Facilities Siting Commission, 1985, 1986). The broad objectives of the criteria are outlined below:

- o protect the residents of the state;
- o ensure structural stability of facility;
- o protect surface water;
- o protect ground water;
- o provide for safe transportation;
- o protect environmentally sensitive areas; and
- o protect air quality.

A 11.1 Human Health Criteria

The legislated human health criteria are summarized below:

- o the facility must be a minimum of 2000 ft. from any occupied structure for impoundment type facilities;

- o the facility must be a minimum of 0.5 mile from any occupied structure for non-impoundment type facilities;

- o the facility cannot be sited within a 20 mile radius of a nuclear fission plant;

- o no unreasonable risk of harm to health, safety or welfare of the population should result from the facility. The following should be considered:

    - the density of the population;
    - the size and type of facility;
    - the type of waste expected;
    - transportation and evacuation routes;
    - facilities in adjacent areas; and
    - availability of emergency services.

A 11.2 Structural Stability Criteria

Structural stability criteria are summarized below:

- o the facility must not be located within a 100-year floodplain;
- o the facility must not be sited within:
  - a coastal flood hazard area;
  - areas underlain by cavernous limestone; and
  - areas overlying past or present mining activities.

A 11.3 Protection of Surface Water Criteria

To protect surface water resources, no major, commercial hazardous waste management facility must be sited within:

- o the upstream portion of a water shed draining into an on-stream reservoir;
- o those watershed areas that drain directly into an off-stream reservoir; or
- o watersheds for waters classified as trout production waters.

A 11.4 Protection of Environmentally Sensitive Areas Criteria

In order to protect significant or environmentally sensitive areas no major commercial hazardous waste management facility shall be sited within or on the following:

- o wetland areas;
- o sensitive habitat areas, unless means are taken to preserve similar habitat either on, or adjacent to the site;
- o designated wild, scenic, or recreational rivers;
- o municipally approved farmland preservation areas;
- o the Pinelands area; or

- o within 6.25 miles of any federal class 1 "Preservation of Significant Deterioration of Air Quality" area.

A 11.5 Safe Transportation Criteria

The following criteria are required to minimize potential risks due to the transport of hazardous waste to a facility:

- o transport is only recommended on highways or other suitably constructed roads;
- o the site be serviced by a direct access road from the highway; and
- o all transport must be within weight restrictions.

A 11.6 Protection of Groundwater Criteria

The following criteria are legislated to protect groundwater resources:

- o the site must be located where the flow of groundwater in the uppermost saturated unit is parallel to or upwards toward the water table and the predominate flow direction is not toward a water body or aquifer used for consumption, and there is no significant recharge to deep aquifers;
- o facilities are prohibited where the depth of the seasonally high water table rises to within 1 foot of the ground surface;
- o impoundments are prohibited in areas where the groundwater travel time in the uppermost saturated unit from the outermost edge of the contaminant structure to the site boundary or surface water body or wetland is less than 10 years;
- o impoundments are prohibited within 1 mile of a well or wells producing 100,000 gallons per day (unless engineering controls are implemented); and
- o partially in-ground structures are prohibited in areas where the seasonally high groundwater table rises to within 5 feet of the containment structure;

A 11.7 Protection of Air Quality Criteria

The following criteria have been established to protect air quality in the vicinity of hazardous waste management facilities. In addition, the criteria set total mass limits for selected groups of compounds.

- o commercial facilities are not allowed in "Air Quality Nonattainment Areas" unless additional emission control measures are implemented. Development in these areas would also be subject to the following more stringent emission restrictions;
  - the annual significant emission increase for volatile organic substances is 10 tons per year; and
  - the annual significant emission increase for total suspended particulates is 25 tons per year.

A 11.8 New Jersey Siting Experience

The New Jersey Hazardous Waste Facility Siting Commission has undertaken a State-wide search for potential sites using the selection criteria defined in the Act. The goal of the siting process is to select sites based on their technical merits, rather than reacting to social or political pressure (Gimello, 1988). The Commission is conducting its activities in an open public forum and has established a proactive public participation program.

The site selection process began in 1981 with the development of the siting criteria and related regulations. In 1986, eleven candidate sites were announced as having potential for further detailed site investigation. All sites were opposed and the Commission has spent more than 10 months in court defending their selection process. None of the legal challenges were successful. At present, several incineration sites are still being evaluated and the four sites proposed for land emplacement facilities have failed to meet the stringent site selection criteria (Gimello, 1988).

A 12.0 State of Oregon

Subsequent to legislative authority under several Oregon State Laws, the Hazardous Waste Management Section has formulated additional siting and permitting requirements for hazardous waste and PCB treatment and disposal facilities. Of interest are land use and other criteria designating sites that are and are not compatible with hazardous waste treatment and disposal facilities.

A 12.1 Siting Criteria

- o There must be at least 250 ft. separation between active waste management areas and facilities and property boundaries except for land disposal facilities where there must be at least 1000 ft. separation.

- o Measures to protect groundwater in the proposed facility area must be assessed using a groundwater quality protection evaluation matrix.

- o To assure low density populations around a facility, the facility must be sited at least:

  - 1 mile from areas with an urban growth boundary of 2,500 people or less;
  - 2 miles from areas with an urban growth boundary of between 2500 and 10,000 people; and
  - 3 miles from areas with an urban growth boundary of 10,000 people or greater.

- o The facility must be sited at least 1 mile from:

  - wilderness, parks, and recreation areas;
  - scenic view sites;
  - Federal and State scenic waterways;
  - destination resorts;
  - rural communities and rural residential areas; and
  - public airports.

- o The facility must be sited at least 1/4 mile from:

  - perennial surface water, estuaries and wetlands;
  - historic and cultural areas
  - ecologically and scientifically significant natural areas;
  - municipal watersheds;
  - flood and slide hazard areas;

- coastal shorelines, beaches and dunes; and
- active seismic faults.

o The proposed facility must not prevent the use of adjacent lands.

o Adequate emergency services, including medical care, must be identified and assessed.

o More than one transportation highway must lead to the facility.

o Transportation routes must be reviewed by the appropriate city, county and state transportation departments.

o In order to encourage local participation in the siting process, committees partly comprising residents living in proximity to the proposed facility are to be appointed.

o An agreement considering local impact of the facilities should be negotiated and consider the following:

- training and equipping of local fire, police and health department personnel;
- on and off-site monitoring of worker and community health;
- road improvements;
- possible changes in property values; and
- a plan to resolve conflicts or disagreements.

A 13.0 State of Pennsylvania

The State of Pennsylvania has adopted hazardous waste treatment and disposal (TSD) facilities siting criteria regulations pursuant to "The Solid Waste Management Act" (P.L. 380, No. 97). Prior to being proclaimed, the criteria were developed in a series of steps that encompassed input from the public and various stakeholders. Criteria for facilities siting are divided into 2 phases. Phase I, exclusionary criteria, encompass those criteria for which engineering solutions are not appropriate and Phase II, cautionary criteria, those criteria for which engineering solutions may be appropriate.

A 13.1 Phase I - Exclusionary Criteria

- o TSD facilities shall not be sited within:
  - 1/2 mile of a well or spring used for a commercial water supply;
  - 1/2 mile either side of a stream or impoundment for a distance of 5 miles upstream of a surface intake for a community water supply; and
  - 1/2 mile of a private or non-community public well or spring used as an active water supply.
- o TSD facilities shall not be sited within a 100-year floodplain or a larger area that the flood of record has inundated.
- o TSD facilities shall not be sited in wetland areas.
- o Facilities cannot be sited over active or inactive oil and gas wells or gas storage areas.
- o Facilities cannot be sited over limestone or carbonate formations that are greater than 5 feet thick and present at the topmost geologic unit.
- o TSD facilities cannot be sited within National natural landmarks and historic places.
- o TSD facilities shall not be sited within dedicated lands in public trust, such as State game lands, fish hatcheries, and wildlife refuges.

A 13.2 Phase II - Cautionary Criteria

- For water supplies which may be affected by the proposed facility a hydrogeologic study detailing the following must be submitted:

  - hydraulic conductivity of the aquifer for the water supplies;
  - hydraulic conductivity of the geologic deposits underlying the proposed facility;
  - assessment of the influence of faults, fractures or other structural geologic features upon hydraulic conductivity and groundwater flow directions; and
  - pumping rates of water supply wells and the extent of pumping depression associated with these wells in relation to the groundwater table of the surrounding areas.

- For water supplies or water treatment plants which the hydrogeologic study indicates may be adversely affected by the proposed facility the applicant must demonstrate:

  - assurance that implementation of a groundwater monitoring well program will provide protection of water supplies or water treatment plants from potential contamination; and
  - the feasibility of providing a permanent alternative water supply acceptable to the water supply owner.

- The following geological constraints should be considered when siting a TSD facility:

  - facilities must be located 1 mile or more from faults;
  - depth to bedrock at the proposed facility should be 15 ft. or greater;
  - facilities should be sited in areas with a slope of 15 % or less;
  - proposed facilities within landslide areas must show adequate design measures against landslides;
  - proposed facility sites will be considered adequate if abandoned oil and gas wells or gas storage areas do not exist within the site;
  - where proposed TSD facilities are located at a site underlain by carbonate bedrock, information regarding the prevalence of solution channels and potential for sinkhole formation must be provided;
  - facilities cannot be located in areas underlain by coarse unconsolidated deposits; and
  - design measures are necessary for proposed facility sites within a 5 mile radius of seismic risk zones.

- Acceptable soil standards for siting TSD facilities are:

  - soil pH for landfarming within the facility must be pH 6.0 or greater; and
  - cation exchange capability of the soil should be 15 meq/100 g or greater.

- In terms of mineral bearing areas:

  - the development proponent should own the mineral rights within the facility and the proposed site has not been previously mined; and
  - if the area has been previously mined, either by deep or surface mining methods, geotechnical studies regarding probability and degree of surface subsidence and proposed methods to stabilize the surface must be provided.

- Facilities should be sited in areas of acceptable land use, including areas where existing TSD facilities are or lands designated for industrial use.

- Transportation aspects deemed necessary for siting of TSD facilities are:

  - facilities should be located within 5 miles of interstate or limited access highways;
  - the route between the closest interstate or limited access highway and the proposed facility should not be the primary access for more than 5 residential dwellings/road mile with no schools, community parks or hospitals; and
  - the above route should have less than 4 intersections/mile.

- TSD facilities must be located within an area possessing adequate safety services, such as fire protection, police and ambulance.

- TSD facilities should be sited 1 mile or greater from an airport, school, community park, hospital, church, retail centre or nursing home.

- TSD facilities should be sited in areas where the proposed facility will not adversely affect the economies of host municipalities.

- Assessment of compensation required should be provided if the TSD facility will result in a net increase in the cost of services provided by the local government.

- Assessment of changes in market value of property resulting from the siting of TSD facilities should be carried out.

- An environmental impact assessment should be carried out in order to evaluate the potential impact of the proposed TSD facilities.

A 14.0 State Virginia

Regulations establishing criteria for hazardous waste management facilities for Virginia have been established under the authority of the Virginia Hazardous Waste Facilities Siting Act. Two sets of criteria are established in the regulations including (1) criteria prohibiting hazardous waste facilities in certain areas; and (2) criteria limiting siting hazardous waste facilities such that environmental factors are assessed.

A 14.1 Prohibiting Criteria

- o No facilities can be sited in wetlands.
- o No facilities can be sited in a 100-year floodplain or a larger area that the flood of record has inundated.
- o Underground injection of hazardous waste is prohibited.
- o No facilities can be sited in areas vulnerable to flooding as a result of dam failure.
- o No facilities can be sited over a sinkhole or less than 100 ft. above a solution cavern beneath the facility associated with karst topography.
- o No facilities can be sited in lands designated as National parks, state, county or municipal parks and important historical and wildlife areas.

A 14.2 Limiting Criteria

- o Siting of a facility must take into account water quality problems (surface and ground water) which may result from the operation of a facility. Water quality aspects to be considered are:
  - proximity of the facility to surface and ground waters;
  - existing quality, and current and future use of the surface and ground waters; and
  - risk to public health and the environment.

- Siting of a hazardous waste facility should not jeopardize a community/noncommunity water system and supply of surface water and ground water.

- Private water systems and supplies of surface and ground water should be protected from the threat of degradation from a hazardous waste facility.

- Siting of a facility must take into account possible air quality problems that may result in terms of:

  - atmospheric characteristics that may affect the site;
  - the population, present and projected, in relation to the facility and the prevailing wind; and
  - characteristics of the wind.

- Storage facilities at commercial port facilities should be given special consideration in terms of public health and safety.

- Facilities cannot be sited in locations that would occupy or threaten the known habitat of an endangered species, plant or animal.

- It must be demonstrated that construction and operation of the proposed facility will not impair the environmental and aesthetic qualities of the area.

- Strong consideration should be given to the possibility of subsidence related with siting facilities above subsurface mining areas.

- Facilities are not to be sited on lands with a slope in excess of 15 %.

- Facilities are not to be sited within 1000 ft. of active faults and seismic risk zones.

- Risk associated with transporting hazardous wastes to the proposed facility must be considered in terms of potentially affected communities, and adverse impacts on the environment and health.

- Proximity of the proposed facility to major structures (eg. schools, churches, retail centres) must be considered.

- The proposed site must be consistent with the local master land use plan as well as with local laws, ordinances, rules and regulations.

- Special attention must be given to the risk of explosion and fire, and measures to deal with these occurrences considered.

- Soil characteristics of the proposed site must be considered in terms of:

  - bearing qualities;
  - stability;
  - drainage; and
  - permeability.

A 15.0 Other States

The following State summaries are provided for those States which responded to our inquiry but do not currently have specific site selection requirements or guidelines.

Delaware

Delaware has no specific siting regulations or a formal site selection process. These are currently being developed and are expected to be adopted in the first half of 1989.

Hawaii

Hawaii has no formal system for site selection and no site selection criteria. Siting for facilities such as landfills and storage facilities is dependent on the Federal requirements found in "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities".

Kansas

No specific site selection criteria are found in hazardous waste management legislation or other pertinent documents for the State of Kansas. Once an application for a facility has been received a board is appointed to review and evaluate the proponent's application. Site criteria are considered during this phase of planning and development.

Nebraska

Nebraska has no legislated siting criteria or any minimum siting requirements in the State hazardous waste management plan. Siting of facilities are considered in the proponent's application for a facility license. Technical aspects of siting are considered by an appointed planning committee once an application for a facility license is received.

North Dakota

Site selection generally follows the federal guidelines. In addition to this, the State proclaimed a regulation in 1984 restricting issuing of permits for facilities located in certain areas. Areas were considered incompatible due to their geology, hydrology, topography and hydrogeology. Decisions as to whether or not a proposed facility site is compatible or not is left up to an approval board.

Rhode Island

While the state has a specific Hazardous Waste Management Facilities Act there are no

provisions for the development of site selection criteria. However, the Act contains a brief section designating where facilities may and may not be sited. Provisions are made in the Act for the preparation and review of siting and impact agreements, as well as for host community compensation.

Utah

Department of Health of the State of Utah is currently in the process of formulating their siting criteria. These will be modelled primarily on the RCRA standards.

Washington

The state of Washington is in the process of repealing its siting standards and will develop an EIS which will identify alternatives for the redevelopment of the siting criteria.

A 16.0 Summary, State Siting Criteria

As indicated, many States in the U.S. have developed site selection criteria for hazardous waste storage, treatment and disposal facilities in addition to the minimum siting regulations established by the U.S. EPA. Many of the criteria established under State control follow a common theme. The following tables summarize common siting criteria and identify the States which have adopted specific criteria. The tables (Temple, Barker & Sloane, Inc., 1987).

Table 1 outlines the criteria which are common between jurisdictions and summarizes the number of States which have adopted them. Tables 2 through 9 summarize State criteria for the following:

- o setback distances from environmentally sensitive areas;
- o States which prohibit or restrict location of facilities over aquifers or recharge zones;
- o setback distances from supply wells or water supplies;
- o setback distances to surface water bodies;
- o minimum depth to water table or aquifer;
- o standards for thickness of soil and hydraulic conductivity;
- o setback distances from property lines, and;
- o setback distances from residences, schools, churches or hospitals.

Individual States may have criteria in addition to these however, these criteria are representative of the primary technical criteria designed to minimize potential facility impact on the environment and public health.

Since 1972, thirty-six States have enacted hazardous waste siting statutes. Thirty-one of these have developed a formal siting process for hazardous waste facilities and ten States have formulated State hazardous waste management plans (Condron & Sipher, 1987).

A total of eighty-one applications for commercial hazardous waste treatment or disposal facilities in twenty-eight States have been submitted since State siting initiatives were enacted (1980). Of these, thirty-six are still in progress. Fourteen applications have been approved under RCRA however, only six of these have proceeded to become operational facilities. Based

on a review of State initiatives for siting hazardous waste treatment facilities, Condron and Sipher (1987) came to the following conclusions:

- State initiative in the siting process promotes siting activity;
- extensive public participation programs promote siting activity and certain elements of the public participation process appear to promote siting approval;
- neither strong State initiative or extensive public participation programs are essential to siting success;
- landfills and incinerators are harder to site successfully than treatment facilities; and
- siting success is influenced strongly by the individual circumstances surrounding each application.

The U.S. EPA has required all States to demonstrate their capabilities to manage hazardous wastes for a twenty year period pursuant to the Superfund Amendment and Reassessment Act (SARA) (Condron & Sipher, 1987). With this new directive, States will come under increasing pressure to site and develop hazardous waste treatment facilities.

Table 1

Common Location Criteria

Protecting Environmentally Sensitive Areas

Criteria	Number of States
Wetlands	23
Endangered Species Habitat	17
Parks, Preserves and Recreational Areas	16
Underground mining, Subsidence Areas	13

Protected Groundwater and Surface Water

Criteria	Number of States
Distance to Supply Wells & Water Supplies	20
Distance to Surface Water	20
Recharge Zones & Aquifers	18
Depth to Water Table or Aquifer	17
Hydraulic Conductivity &/or Soil Thickness	15
Soil or Rock Type	12
Karst Area	12

Ensuring Adequate Buffer Zone

Criteria	Number of States
Distance to Property Line	18
Distance to Residence	17

Note: includes proposed criteria for some States
Source: Temple, Barker & Sloane, Inc., 1987)

Table 2

Setback Distances From Environmentally Sensitive Areas

Area	Distance	State
Wetlands	1 mile	Nevada
	1,000 feet	New Hampshire
	0.25 miles	Oregon
	500 feet	Rhode Island
Endangered Habitat	1 mile	Nevada
Parks and Preserves	1 mile	Nevada
	1 mile	Oregon
Mining, Subsidence Areas	1 mile	Nevada
	200 feet	North Carolina
	1,000 feet	West Virginia

Note: Includes proposed criteria for some States.

Source: Temple, Barker & Sloane, Inc., 1987)

Table 3

States that Prohibit or Restrict Location of Facilities Over Recharge Zones or Aquifers

State	Location	Applicability
Alaska[1]	Sole source aquifer	All facilities
Arkansas	Recharge zones of sole source aquifer	All facilities
Delaware	Recharge areas	Land-based facilities
	Public water supply recharge areas	Non land-based
Maine	Recharge zones and aquifers	Land-based facilities
Maryland	Aquifers	All facilities
Massachusetts	Groundwater drinking supplies	Land-based facilities
Michigan	Sole source aquifers and recharge zones	Land-based facilities
Missouri	Recharge zone	Land-based facilities
New Hampshire	Aquifer with yield of 72,000 g/d	All facilities
North Carolina	Recharge zone of sole source aquifer	Land-based facilities
North Dakota	Recharge area	All facilities
Rhode Island	Potential groundwater drinking sources	All facilities
Texas	Recharge zone of sole source aquifers	Land-based facilities
Washington	Recharge zone of sole source aquifer	Land-based facilities
West Virginia	Public water supply recharge areas	All facilities

[1]Note: regulations in this State are proposed.
[2]Applicability may mean landfills only in some cases.

Source: Temple, Barker & Sloane, Inc., 1987)

Table 4

Distance to Supply Wells or Water Supplies

State	Distance	Applicability
Alaska	500 metres	New and expanding land-based facilities
Arkansas	1000 feet	New land-based facilities
Delaware	0.25 miles	All land-based facilities
Idaho	1000 feet	All land-based facilities
Illinois	1000 feet	New land-based facilities
Maine	1000 feet	All new and expanding facilities
Massachusetts	1000 feet	New and expanding land-based facilities
Missouri	500 feet	All land-based facilities
Nevada	1 mile	All new facilities
New Hampshire	5000 feet	New land-based facilities
New Jersey	1 mile	New and expanding land-based facilities
Pennsylvania	0.5 mile	New land-based facilities
North Carolina	1000 feet	New land-based facilities
Rhode Island	500 feet	New and expanding land based facilities
Texas	500 feet	New land-based facilities
Washington	500 feet	All new and expanding facilities
Wisconsin	1200 feet	New and expanding land based facilities

Note: includes proposed regulations

Source: Temple, Barker & Sloane, Inc., 1987)

Table 5

Distances to Surface Water Bodies

State	Distance	Type of Surface Water Body
Alaska[1]	1500 metres	Surface water
Arkansas	500 feet	Surface water
Idaho[1]	2500 feet	Surface water
Minnesota	1000 feet 300 feet	Lake, pond, reservoir Stream
Nevada[1]	1 mile	Surface water
New Hampshire	1000 feet 1500 feet	Large pond, lake, reservoir Large river or stream
North Carolina	200 feet	Surface water
Oregon	0.25 mile	Surface water
Rhode Island	500 feet	Surface water
Washington	500 feet	Surface water
Wisconsin	1,000 feet 300 feet	Lake, pond River, stream

[1]Note: includes proposed criteria in these States

Source: Temple, Barker & Sloane, Inc., 1987)

Table 6

Depth to Water Table or Aquifer

State	Distance	Applicability[2]
Alaska	10 feet	All land-based facilities
Arkansas	150 feet	New land-based facilities
California	5 feet	All land-based facilities
Delaware	above	New land-based facilities
Idaho[1]	100 feet	New land-based facilities
Iowa[2]	100 feet	State owned facility
Kentucky	above	New land-based facilities
Maryland[2]	100 feet	New land-based facilities
Minnesota	above	All land-based facilities
Mississippi	20 feet	New land-based facilities
Missouri[2]	30 feet	All land-based facilities
Nevada[1]	150 feet	All new facilities
New Jersey	5 feet	New land-based facilities
North Carolina	10 feet	New land-based facilities
Oklahoma	15 feet	New land based facilities
Texas[2]	100 feet	New land-based facilities
Washington[2]	50 feet	New land-based facilities

[1]Includes proposed regulations in these States.
[2]Applicability may relate to landfills only in some cases.

Source: Temple, Barker & Sloane, Inc., 1987)

Table 7

Standards for Thickness of Soil and Hydraulic Conductivity

State	Thickness of Soil	Hydraulic Conductivity Limit (cm/sec)	Facility Applicability
California	Sufficient	$1 * 10^{-7}$	All land-based
Colorado	Sufficient	$1 * 10^{-7}$	New land-based
Idaho[1]	25 feet	-	New land-based
Maine	5 feet	$1 * 10^{-7}$	All new and expanding
Maryland	30 feet	-	New land-based
Michigan	6 metres	$1 * 10^{-6}$	All new and expanding
Mississippi	-	$1 * 10^{-7}$	New land-based
Missouri	30 feet	$1 * 10^{-7}$	All land-based
New Hampshire	Sufficient	$1 * 10^{-7}$	All new facilities
N. Carolina	20 feet	$1 * 10^{-7}$	New land-based
Oklahoma	10 feet	$1 * 10^{-7}$	New land-based
Texas	10 feet	$1 * 10^{-7}$	New and expanding land based

[1]Note: includes proposed regulations in this States

Source: Temple, Barker & Sloane, Inc., 1987)

Table 8

Setback Distances From Property Lines

State	Distance
Alaska[1]	500 metres
Arkansas	200 feet
Connecticut	400 feet
Idaho[1]	500 feet
Louisiana	200 feet
Maine	200 feet
Massachusetts	200 feet
Michigan	150 metres
Missouri	300 feet
New Hampshire	500 feet
North Carolina	200 feet
Oklahoma	200 feet
Oregon	1,000 feet
Texas	200 feet
Washington	200 feet
Wisconsin	200 feet

[1]Note: includes proposed criteria in these States

Source: Temple, Barker & Sloane, Inc., 1987)

Table 9

Setback Distances From Residences Schools, Churches, or Hospitals

State	Distance	Type of Structure
Delaware	1,500 feet 2,000 feet	Residence School, church
Idaho[1]	5,000 feet 3 miles	Residence School, church
Mississippi	1,000 feet 0.5 mile	Residence School, hospital
Nevada[1]	1 mile	Residence
New Hampshire	1,000 feet 3,000 feet	Residence School, hospital
New Jersey	2,000 feet	Residence
North Carolina	0.25 miles	School, church
Oregon	1 mile	Residence, school, church
Pennsylvania	1 mile	School, church, hospital
Texas	500 feet	Residence, school, church
Washington	2,000 feet 2,000 feet	Residence School, church, hospital

[1]Note: includes proposed criteria in these States

Source: Temple, Barker & Sloane, Inc., 1987)

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APPENDIX B

SITE SELECTION CRITERIA AND APPROACHES IN CANADA

The following sections outline the site selection process and siting considerations or criteria which have been applied in recent or ongoing hazardous waste facility development proposals in Canada.

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B 1.0 The Alberta Special Waste Management Corporation

The Alberta Special Waste Management Corporation (ASWMC) has successfully sited and developed a hazardous waste treatment and disposal facility at Swan Hills, Alberta. The siting process began in 1981 and included an extensive public participation program. A set of siting criteria were developed early on in the process to delineate lands which could be considered as candidate locations on a provincial basis. These criteria included physical, biological, land use and human constraints (McQuade-Cook & Simpson, 1986).

In 1981, all counties, municipal districts, improvement districts and special areas designated in the province were included in and received briefing sessions on the site selection process. General information on the types of criteria which may be used in the siting process were included. Following these initial information sessions, local authorities were given the option of participating further in the program. In order to proceed, local authorities were required to write a formal invitation to assess the suitability of siting a facility in their jurisdiction. Written submissions were received from 52 of a possible 70 jurisdictions. Studies were then undertaken in these jurisdictions by the government, at no cost to the municipality, and results were made available to the public. Twenty-five percent of the areas studied requested further consideration as a possible host community for the facility

Many areas were excluded on environmental grounds, while others were eliminated because of vocal public opposition. A total of five potential host communities underwent more detailed site selection processes which included site specific geotechnical investigations. All five areas held plebiscites to establish public support for the facility. Officially, two primary sites, Swan Hills and Riley, emerged from this process. Both sites were presented as acceptable alternatives by the Corporation and the final selection was made by a Cabinet decision.

The Alberta site selection process weighed heavily on public support to identify candidate regions. The technical criteria (constraints) used to identify candidate areas within interested municipalities included the following:

Physical Constraints

- areas with significant gravel or sand lenses, fractures, or groundwater were eliminated,
- all areas adjacent to surface water bodies or aquifers were eliminated,
- areas exhibiting steep or unstable slopes were not considered, and
- seismic activity was reviewed and considered for candidate sites.

Biological Constraints

- o Areas exhibiting high potential for productivity were avoided. This included soil productivity for agriculture, forestry potential and important wildlife lands.

Land Use Constraints

- o the following land use areas were eliminated from consideration

  - prime farm land,
  - grazing reserves,
  - ecological reserves,and
  - all federally owned land

Human Constraints

- o areas exhibiting prehistoric, historic and cultural significance were eliminated, and

- o areas of intensive recreation were avoided.

These criteria were mapped on provincial base maps for public distribution. All information was made available to the public and candidate municipalities (those who requested formal consideration as host communities) were invited to select parcels in constraint free areas for further consideration. As indicated, detailed investigations were conducted on a total of five candidate sites prior to selection of the Swan Hills site (McQuade-Cook & Simpson, 1986).

B 2.0 British Columbia

British Columbia has recently embarked on the development of an integrated hazardous waste management facility for the province. A consortium of private companies (B.C. Special Waste Services Inc.) has been selected by the provincial Special Waste Advisory Committee (SWAC) to act as proponent for the project (pers. comm. Mr. T.W. Finnbogason, March, 1988). The site location will be selected by the proponent with input from (SWAC).

Preliminary site selection considerations have been developed by B.C. Special Waste Services Inc.. These siting considerations have been technically reviewed by SWAC as part of the proponent's proposal. Communities have been contacted to identify potential host regions. A detailed site selection process will be conducted within the host community selected for the project.

The following considerations will be addressed in the site selection process (pers. comm. Mr. T.W. Finnbogason):

Physical Site Characteristics:

- Topography
- Soil characteristics
- Surficial geology
- Aquifer characteristics
- Proximity to:
  - floodplains
  - holocene faults
  - areas subject to tsunamis
  - areas subject to slope failures
- Drainage (to wetlands)
- Seismic acceleration
- Water table
- Soil permeability
- Groundwater recharge capabilities
- Bedrock characteristics
- Proximity to water bodies
- Proximity to community water supplies
- Precipitation/evaporation

Land Features

- Availability of buffer zone
- Proximity to populated areas
- Current site land use
  - exclude parks
  - exclude wildlife areas
  - exclude ecological reserves
- Presence of non-renewable resources
- Land claims
- Capability for supporting waterfowl, ungulates
- Availability
- Cost
- Tax rates

Climate and Meteorology

- Precipitation
- Evaporation
- Temperature
- Air dispersion meteorology

Site Services

- Water
- Electricity
- Natural gas
- Effluent receiving streams
  - permitted sanitary wastes
  - permitted facility discharges

Community Infrastructure

- Transportation features
- Availability of emergency response services
- Ability to attract and hold labour force

Local Labour Force

- Size
- Skills
- Availability

Market Access

- Distance from waste generators
- Transportation
  - proximity to main routes
  - accident risk potential
  - environmental sensitivity of corridors
  - alternative transportation modes and routes

These considerations will be developed into a set of siting criteria for facility development which are consistent with the requirements of the new Special Waste Regulation (B.C. Reg.63/88, April 1, 1988).

The following minimum siting standards have been established under the Special Waste Regulation for all special waste management facilities; facility development will not be permitted in the following areas:

- a 100-year flood plain;
- within 100 m of a holocene fault;
- areas subject to tsunamis;
- within 100 m of land subject to slope failure;
- national, provincial, regional or municipal parks;
- wildlife management areas;
- ecological reserves;
- bird sanctuaries; and
- designated wildlife areas and critical wildlife habitat.

In addition, secure landfills, surface impoundments, waste piles, land treatment facilities and long term storage facilities have the following location restrictions:

- wetlands;
- seismic prone areas;
- recharge areas for unconfined aquifers;
- must be constructed totally above the seasonally high water table, and have a minimum depth of 3 m unsaturated soil material with a hydraulic conductivity less than $1*10^{-6}$ cm/s above a seasonally high water table;
- must have a minimum of 5 m of fine grained unconsolidated material with a hydraulic conductivity less than $1*10^{-6}$ cm/s over fractured or permeable bedrock formations;
- must not be within 300 m (secure landfills), 150 m (waste piles, surface impoundments and land treatment facilities) or 100 m (long term storage facilities) of any nonintermittent watercourse or any permanent waterbody;
- must not be within a designated community water supply watershed or in a

recharge area for an unconfined aquifer with one or more high capacity wells (>100 litres/minute);

- o precipitation rates must not exceed evaporation and transpiration rates; and
- o an approved secure buffer zone must be provided around the active area of secure landfills

The development schedule for the B.C. facility is very ambitious. The selection of candidate areas, determination of community interest, detailed community involvement program and preliminary site area evaluation steps are all scheduled to be completed in 1988. The key element in this process is the selection of a host community. A number of communities have expressed an interest in the project and these are currently being evaluated by the proponent. The selected community must support the project in order for the proponent to proceed to the permitting stage (pers. comm. T.W. Finnbogason)

The proponent will submit a project development proposal to the Minister and commence permitting activities and detailed site investigations following selection of a host community.

B 3.0 The Ontario Waste Management Corporation

The Ontario Waste Management Corporation (OWMC) has undertaken an extensive site selection process within Southern Ontario. The process included a number of site selection phases, each one concentrating on a smaller area and introducing more detailed selection criteria.(OWMC, 1988)

The initial phase identified areas within Southern Ontario where the geological and hydrogeological conditions were suitable for further consideration for facility development. Interest quickly focused on the Golden Horseshoe region since this region produces the major portion of the province's wastes. Phase 2 identified two areas within the Golden Horseshoe region where the detailed search for candidate regions should concentrate. More detailed criteria were then developed to meet the following site selection objectives. Candidate areas should:

- o provide a second natural level of protection of the environment beyond that provided by engineering design,
- o identify areas which have a good probability of satisfying the site requirements subject to further detailed examination, and
- o there must be assurance in the process that no significant alternatives are being excluded (OWMC, 1984).

Phase 3 of the site selection process was the selection of candidate sites. These were selected with the following goals in mind (OWMC, 1984):

- o minimize risk to human health,
- o minimize environmental impacts, and
- o minimize financial costs to OWMC.

The site selection process was conducted using the "constraint mapping" approach. The following factors were considered unsuitable for facility development when considering all facility components (OWMC, 1984):

Physical Resources

- o surficial granular soils
- o significant stream resources

- flood plain areas
- wetlands
- drumlins
- morainal features

Land Use

- Indian reserves
- residential, built-up
- residential, designated and serviced
- commercial, designated and built-upon
- commercial, designated and vacant
- existing rural residential

Recreation and Community Facilities

- hospitals
- homes for the aged
- colleges and universities
- nursing homes
- special educational facilities
- police headquarters
- theme parks
- regional shopping centres
- correctional facilities
- institutions for the handicapped

Transportation

- airports

Agriculture

- existing speciality crops
- class 1 and 2 row crops and corn wheat
- class 1 and 2 mixed, cereal grain and hay grain
- class 3 row crops and corn wheat
- class 3 mixed, cereal grain and hay grain

- class 1 and 2 hay and grazing
- class 4 row crops and corn wheat
- class 4 mixed, cereal grain and hay grain

Following completion of this screening exercise, the relative suitability of candidate sites was evaluated using "comparative evaluation factors" which included human, physical and biological environment, and economic factors. A short list of potential sites was generated in this process for further detailed investigation.

B 4.0 Siting Criteria; Manitoba CEC Hearings

The Manitoba Clean Environment Commission (CEC) has held a series of hearings soliciting public involvement and comment on issues related to hazardous waste management in the province.. The most recent set of hearings, conducted from November 12, 1986 to January 20, 1987, addressed the issues of facility development options and facility siting. Based on submissions presented at these hearings, the CEC has made several recommendations related to the development of siting criteria and public involvement in the site selection process (CEC, May 1987).

B 4.1 Hearing Submissions

Hearings were held at eleven regional centres throughout the province. A number of formal submissions were received by the Commission and public attendance at the hearings was estimated at approximately 450 individuals.

Concerns and recommendations received by the CEC on the siting of a hazardous waste management facility are summarized below:

- the facility should be located on an impervious clay base,
- the following topographical and land use characteristics should be avoided:
  - wetland areas,
  - prime agricultural land,
  - steeply rolling terrain,
  - areas subject to erosion and slumping,
  - areas with fractures leading to groundwater aquifers,
  - biologically sensitive areas,
  - archaeological and historic sites,
  - areas of high population density, and
  - areas with resource development potential.
- the facility should not be located in groundwater recharge areas or areas with seasonal high groundwater tables,
- areas of high natural hazard risk (i.e. tornadoes, floods) should be avoided,

- the facility should have local public support,
- local wind patterns and facility location with respect to local population centres should be considered,
- the facility should be located on Crown land or on a sufficiently large tract of land to permit establishment of an adequate buffer zone,
- there must be provision for the on-site disposal of detoxified effluent from treatment processes (eg. evaporation pond, deep well disposal or disposal to surface water),
- the facility should be located close to waste generators to minimize transportation risks,
- site services and road access must be available and rail access would be an advantage, and
- a community must be within reasonable commuting distance to provide services for the facility work force.

These siting considerations and concerns represent a wide range of interests. The above summary represents viewpoints expressed by the general public, local governments, industrial and commercial interests

B 4.2 Commission Recommendations

The following recommendations were made by the CEC following review of submissions and public discussion related to the issue of facility siting:

- the Crown Corporation should utilize information presented at these public hearings and criteria developed in other jurisdictions (Alberta and Ontario) to assist in the preparation of comprehensive and detailed site selection criteria,
- acceptance of the Crown Corporation's criteria should be obtained through the public hearing process,
- hydrogeological qualification of a site is the most important technical and engineering consideration whereas, public acceptability is the most important socio-economic consideration, and

- the site should located within reasonable distance of Winnipeg, where a major portion of the wastes are generated, to limit transportation risks and cost.

In summary, the CEC felt it was essential to involve the public in the site selection process, particularly in the development of siting criteria. With respect to technical issues, the CEC felt hydrogeological concern should be given priority and a location close to waste generators would be preferred.

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PERSONAL COMMUNICATION

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APPENDIX C

SPANS™ GEOGRAPHICAL INFORMATION SYSTEM

General Information

APPENDIX C

THE COMPUTERIZED MAPS

General Information

The maps in this report have been generated with the aid of a computer-based Geographic Information System (GIS). This technique uses a computer for overlaying geographic information onto a map of the province. For example, the area shown under the Environmental Protection category in (Figure 4-10) is a composite of information that was originally entered separately from several other maps - one showed groundwater pollution hazard areas, another provincial parks, a third one best agricultural land, etc.

There is no magic in using a computer for this; the information that it generates is only as good as the data that were put in originally, or as good as the original information from which the maps were drawn.

However, the computer affords a great advantage in handling the data. It can automatically adjust the scale of different maps, so that the information can be viewed at the same time. It allows the user to change colors for presentation easily, without the requirements for redrafting the figures. It makes it possible to create new maps that fulfill various criteria. For example, a new map can be generated that would show only those agricultural lands that do not lay within groundwater pollution hazard areas. While a number of maps must be digitized (a process that allows the computer to use them), much of the necessary information is now available in data base form from various government and private sources. This reflects the growing use of this technique in land use planning.

Technical Background

The specific GIS used by the Corporation in the site selection process is the SPANS^{TM}, Spatial Analysis System, implemented for use on PC AT-type microcomputers. It stores data in a quad-tree structure. Conversion of existing databases from a range of other popular GIS formats and image processing systems is also supported.

The SPANS^{TM} was developed and is distributed by TYDAC Technologies, a Canadian company based in Ottawa. Systems are operated by a number of consulting firms on a commercial basis and directed by users such as the Corporation.